AUTOMATIC DATA PROCESSING
DECEMBER 1959 3 6

MARKET FORECASTING ORDER HANDLING ACCOUNTING FINANCIAL AND COST CONTROL DELIVERY SCHEDULING STOCK CONTROL
AUTOMATIC MACHINE CONTROL PROCESS CONTROL DATA LOGGING PRODUCTION CONTROL RESEARCH AND DEVELOPMENT

Automatic Data Processing

Vol 1 No 11

Automatic Data Processing

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COVER PICTURE

A monster tyre, one of the lines of a rubber goods manufacturer, whose systems are examined in an article beginning on page eight

AUTOMATIC
DATA PROCESSING

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READING GUIDE

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CONTENTS CONTINUED

The Editor, the Advertisement Director and the Staff of AUTOMATIC DATA PROCESSING wish all their readers and advertisers happiness and prosperity in the New Year

Comment

Looking Ahead

WE have now had time to analyse the replies we received to the questionnaire that was sent out with the October issue of AUTOMATIC DATA PROCESSING and the conclusions to be drawn from it are encouraging.

We owe thanks to the many readers who took the trouble to fill up the form and to indicate their preferences. We are pleased that in the main our editorial policy has been very convincingly vindicated. There was only one really disgruntled reader among all those who replied to our questions and added their own very helpful comments and suggestions. We hope that even he will be pleased by the developments that we have planned for 1960; and we are confident that all our satisfied readers will find that the interest and the usefulness of AUTOMATIC DATA PROCESSING will increase steadily as the months go by.

In a field of revolutionary industrial and scientific development, in which many of the implications are difficult to assess, there are bound to be doubts and hesitations from time to time; but we conceive our role to be a multiple one which should combine information of new thought and practice, records of past experience and a forum for discussion of problems.

Above all, we shall try to keep the tremendous significance of the electronic revolution in perspective and its numerous manifestations under constant review. We see it not as something happening in isolation, but primarily as a social phenomenon that has had, and will increasingly have, profound effects upon the practice of management.

The electronic machines with which this revolution is associated in all our minds are merely inert instruments until they are set to work by human ingenuity. Their peculiar marvel is the potency they can bring to systematic planning. Consequently, it is with the problems of management, and particularly the problems of organisation, that we shall be most concerned in 1960.

Our newly designed cover, which will appear on our January issue, expresses our alertness to change and our readiness to go along with the tremendous scientific and industrial advances of our era. We hope that all our readers will share with us the prosperity that these great advances will bring.

THE CLEARING HOUSE IDEA at North British Rubber

The North British Rubber Company are not yet computer users, but in a highly organised punched card installation they have already achieved a far-reaching degree of integration in their clerical work

By MALCOLM ROSS

IN its two factories—one at Castle Mills, Edinburgh, and the other at Heathhall, Dumfries—The North British Rubber Co Ltd (a subsidiary of the US Rubber Company) manufacturers a wide range of rubber products, such as tyres for passenger and commercial vehicles,conveyor belting, hoses, many kinds of footwear, rubber flooring, marine fendering for harbours, extrusions and industrial protective clothing.

Manufacturing these products is organised in three set-ups: a tyre division, a footwear division and a mechanical division.

As with many other manufacturing concerns, the company needs to know what to make tomorrow to replenish what is being sold today, and more than that it also needs to be able to anticipate future troughs and peaks in the demand pattern and gear production accordingly.

This information—in a form on which the company's management can usefully act—is produced by a central machine accounting department located at headquarters in Castle Mills. Using conventional punched card equipment rented from IBM, the department has, for example, evolved procedures—at present only for the tyre division—which materially assist in the co-ordination of production and sales.

Since IBM equipment was installed in 1955,

five major applications, entailing the preparation of some 83 main reports, have been taken over by the department; the work of many departments is being integrated, and management is being provided with the closer control that machine accounting makes possible.

THE 'TOTAL' APPROACH

The notion of 'integrated systems,' whether in punched card or computer installations, has been paid a good deal of lip service, yet while its praises are sung, its precise meaning and implication are occasionally forgotten.

In many punched card installations 'integration' is progressively introduced: at a very simple level it may mean that a set of punched cards used for one tabulation may provide the data required for another set of management statistics and so the original punched and verified cards can be used to reproduce automatically selected data into a fresh pack of cards. Clearly, whenever it is convenient to do this, accuracy is automatically obtained and time will be gained.

Starting from this simple idea of drawing on information prepared for one purpose and applying it to several others, it is not difficult to envisage a punched card installation as an over-all clearing house where different sets of facts, emanating from all departments within a company, are married up in different ways to produce various reports for those departments.

This notion of integration only becomes feasible with the introduction of, at least, punched card equipment, and has three aims:

1—to cut out duplication of clerical effort in company departments;

2—to simplify work in the punched card department;

3—to produce faster, more complete, and often more economical results.

Certainly North British's machine accounting department has arranged the work of their card equipment in accordance with this notion. Of all the major jobs run on their set-up, none is handled as a distinct procedure—each is coupled with at least one other 'clerical job.'

Essentially, the machine accounting department at Castle Mills is concerned with five major areas of clerical work. These are accounting and forecasting, market research, sales-production co-ordination, payroll, distribution of labour costs. Also, at present emerging from the development stage, are procedures to control accounts payable and the distribution of raw materials.

ACCOUNTING AND FORECASTING

For example, under the generic heading of the 'accounting and forecasting work' the machine accounting department produces daily sales figures, for all divisions (tyres, footwear and mechanical) by major outlets. Also it provides on the 10th, 20th, 27th and the last day of each month a breakdown of sales by major outlets and commodity codes which is designed to assist in predetermining sales for the current month. Then, within a few days of the month's end fully detailed reports of the sales achievement—by commodities, grades, and representatives—for the current month are made available to management and that, in turn, is followed by the sales ledger which shows a complete breakdown of the gross sales, returns, various discounts and allowances analysed by credit type, along with the controlled standard cost of sales. This sales ledger breakdown plays a large part in arriving at the profit and loss accounts which, in common with most large business concerns, are drawn up at the end of every month so that an accurate, up-to-date picture of the company's financial performance can be made available to management with the least possible delay.

There are also many other miscellaneous reports prepared for the accounting and forecast department which assist generally in the control of their operations.

This dovetailing of accounting and forecast work is made possible to a large extent by the amount of detail that the company post onto their invoices to customers. All billing is done at Castle Mills (though not by the machine accounting department) and copies of these invoices—some 11,000 a month—are sent to the machine accounting department. For each line of an invoice a sales distribution card (approximately 28,000 are required a month) is punched with such details as the document number, customer code, the depôt from which the sale was made, the location of the inventory, the representative's code, the commodity code and grade, the standard cost of the sale, and in the case of the tyre division the inventory detail code and the number of units sold.

Some of the information punched and verified on the sales distribution card is not utilised directly by the accounting and forecast department but is for the unit control of tyre division inventories and unit sales statistics. This is reproduced automatically onto another deck of cards, while irrelevant data is omitted. Yet another deck of cards is reproduced from the original sales distribution cards, in this instance containing only information relevant to that particular application. Thus, within an hour or so of the final sales distribution card being punched and verified at the month's end, three decks of cards are available from the one source document, for three major applications, each going their own separate ways, each application meeting its own deadline, without fear of

being held up because the cards are being utilised in preparing another set of reports.

SALES—PRODUCTION CO-ORDINATION

At the moment the procedures that have been evolved by the machine accounting department to coordinate sales and production are restricted to the tyre division. This job revolves round the control of inventories in all locations, control of finished production, unit sales statistics, control of slow moving, surplus and short supply inventories, forecasting future production requirements, the pricing of inventories and finished production at standard cost at the month's end.

At present a daily inventory availability report, which includes details on production, despatches, returns and stock transfer up to 4 pm the previous day, is required by the Sales-Production co-ordination department by 8 am each day. This information is utilised by the machine accounting department for the processing of orders during the current day's operations and is again brought up to date each afternoon.

A daily listing of finished goods production is produced on a high-speed 421 accounting machine, which shows that day's production against a production forecast, with the total production for the month against the forecasted production to date. All production units from the inspection and delivery tickets are punched as credits and reproduced as debits on the 519 reproducing punch for inclusion in the inventory. In other words a conventional book-keeping double entry is made.

In the same manner the unit sales are punched as credits for relieving the inventory and, by the use of alteration switches on the 421 machine, shown as

further movement was made, what the inventory position would be at the month's end.

(d) All of this information—(a), (b), (c),—has been prepared from data currently available in machine accounting department, and, at this point, a summary card is cut for each size of tyre and tube, containing the forecasted position at the month's end.

Stage 2

(a) The forecasted inventory position is then collated with the known outstanding commitments—orders received from the motor trade, branches, Castle Mills and abroad. Cards are punched and verified for these items from the data supplied by the Sales Production co-ordination department.

(b) In addition a regular 'synthetic' order—one-fifth of the standard 10-week inventory position—is also collated.

(c) A figure for the inventory position at the end of the month which takes into consideration all of the anticipated current month's commitments is how available, and, at this point, a summary card is again cut for each size of tyre and tube showing that position.

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In the same manner the unit sales are punched as credits for relieving the inventory and, by the use of alteration switches on the 421 machine, shown as debits in the various unit sales reports that are made on behalf of the Sales-Production co-ordination department. The various sales reports follow the same trend as that for the accounting and forecast department, the difference being that they are expressed in units instead of sterling.

Another aspect of sales production co-ordination concerns planning the following months' production. This is accomplished in three stages.

Stage 1

(a) A check is made on inventory movement on approximately the 15th of each month.

(b) The balance of production due for that month is determined—by subtracting the units produced to date from the total scheduled production for the month. This figure is added to the available inventory figure (a).

(c) Thus a figure, for each size of tyre and tube, is made available, which shows, if no further movement was made, what the inventory position would be at the month's end.

(d) All of this information—(a), (b), (c),—has been prepared from data currently available in machine accounting department, and, at this point, a summary card is cut for each size of tyre and tube, containing the forecasted position at the month's end.

Stage 2

(a) The forecasted inventory position is then collated with the known outstanding commitments—orders received from the motor trade, branches, Castle Mills and abroad. Cards are punched and verified for these items from the data supplied by the Sales Production co-ordination department.

(b) In addition a regular ' synthetic ' order—one-fifth of the standard 10-week inventory position—is also collated.

(c) A figure for the inventory position at the end of the month which takes into consideration all of the anticipated current month's commitments is how available, and, at this point, a summary card is again cut for each size of tyre and tube showing that position.

Stage 3

(a) The next step is to compare the anticipated inventory position with the following month's sales forecast—export sales and the tyre needs of two motor car companies known in advance. Again cards are punched and verified for these items from the data supplied by the Sale-Production co-ordination department.

(b) Additionally the standard 10-week inventory position is collated with the sales forecasts.

(c) This operation will indicate—for each size of tyre and tube—one of two conditions: whether there will be in following month abundant stocks (a debit figure will be shown) or whether more production will be required. (A credit shows what is actually required to be scheduled for production in the following month and is totalled for the various types of tyres and tubes required.)

(d) In the Sales-Production co-ordination department the total production requirements is compared with the capacity of the plant, and if in excess a pro-rata cut back is made on the individual schedule requirement. This of course is based on the experience of the Sale-Production co-ordination department manager and his staff.

All cards punched in the machine accounting department are subsequently verified. This is important as an error on a card might in some cases be triplicated automatically

BY-PRODUCT PAYROLL

The fourth area of clerical work undertaken by the machine accounting department is concerned with the preparation of the payroll for all the people concerned at Castle Mills. This payroll is not prepared in isolation; in fact it is produced as the by-product of another operation—labour cost distribution. The basic record for this procedure is a *labour distribution card* which is prepared from the information supplied on a production schedule made out for every operative. This schedule is rated and transcribed by the timekeeping staff onto pay schedule, and from that data, the machine accounting department punch and verify a card for each individual item. These cards contain details of clock number, distribution codes, hours worked and the hourly rate.

Preparing and finalising the payroll involves following a tight schedule: the factory payroll closes on Saturday afternoons, the maintenance engineers Sunday afternoons, and the final information relating to these payrolls has to reach the machine accounting department by 4.30 pm each Tuesday.

Most of each Monday is taken up with the punching and verifying of the first batch of factory and engineers' pay schedules and during the course of Tuesday labour distribution cards are extended and summarised onto a 'gross pay this week' card by the 604 electronic calculator, and an advice of gross pay is printed on the 421 accounting machine. On completion, each successive group is collated with the previous group of labour distribution and 'gross pay this week' cards. For the printing of the pay advices the labour distribution cards are collated with the employee's master card, in order that the full name and clock number be shown.

On completion of the pay advices each Tuesday

In a card library are held punched cards for current jobs and also the 'result' cards of previous jobs—should re-runs be necessary

night, the labour distribution and the 'gross pay this week' cards are totalled on the 421 machine to ensure that the labour cost distributed is in balance with the gross pay.

The labour distribution cards are then held, pending final clearance by the payroll department. This is generally received around 11 am on Wednesday mornings.

At 8.30 am on Wednesday work is commenced on actually producing the payroll. The master cards are collated with the gross pay this week cards. The variable and standard deduction cards, the previous week's tax cards and any P45's, etc, are in turn merged with this master deck. They are then summarised on the 421 accounting machine to produce a summary card for each employee, which becomes the current week's tax card. Also built into this summarisation is a procedure for adjusting National Insurance contributions that vary from standard.

These cards—the current week's tax cards—contain all the details necessary from the calculation of PAYE and net pay, ie, gross pay to date, tax paid brought forward, weekly free pay, tax status (normal, non-taxable, week one and emergency), taxable and non-taxable deductions. From this information the 604 electronic calculator, in a single run, calculates and punches the tax due to date, tax this week and net pay this week.

On the completion of the tax run on the 604 the current week's tax cards are checked on the collator for tax refunds over £5. These tax refunds over £5 are referred to the paymaster for clearance before further processing.

The next stage on the payroll is to crossfoot the tax cards and balance back the gross pay with the total already obtained from the labour distribution cards. As this run also shows up the net pay, it is used by the payroll department to balance back the net pays after the pay envelopes have

been filled with the relative amount of cash.

After that comes the printing of the pay envelopes three cards being used for each employee to produce three lines of print. The first of these is the employee's master card which contains name and clock number as well as other fixed information, the second is the standard deduction card which is automatically reproduced from the master card; this, in order that a deduction analysis may be later carried out without disturbing the employee's master card file. The third is the current week's tax card which also includes any variable deductions. On completion of the printing of the pay envelopes on the 421 accounting machine they are separated on a 'Fanfold' burster, and the cards are rerun on the 421, for the printing of the actual payroll.

DISTRIBUTION OF LABOUR COSTS

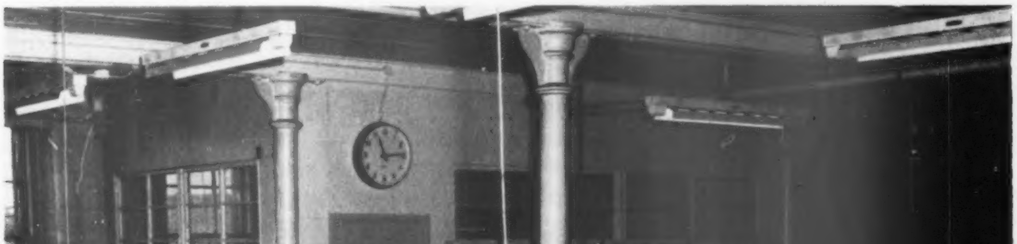
When a clearance is received from the payroll department on Wednesday mornings, the Labour Distribution Cards are broken out from cloc number, and sorted to a sequence that covers all codings. They are then summarised on the 421 machine and a summary punch is used to break down the volumes of cards.

On completion of the summarisation, the total of the summary cards is checked against the gross payroll for that week. Various reports (7 for the factory and 5 for the maintenance engineers) are then prepared, showing an analysis of labour cost under various headings—eg: standard direct labour, direct labour variations, indirect labour etc. (each of these being sub-classified into various codes).

Weekly tabulations of moneys paid out under these codings are completed by noon each Thursday and circulated to management and supervision as early as possible.

It is important that this data is circulated prior to the time of payment, to keep management alive to the fact that moneys are being disbursed, and that the controllable excesses are their responsibility.

Each job (apart from initial punching) is the responsibility of one operator who progresses the work from machine to machine and is responsible for the final results



WHAT IS PROGRAMMING?

An explanation of what the word means, what precisely it involves, and how it may be simplified (if not eliminated) in the future

by A S DOUGLAS

THE use of the verb 'to program' (or 'to programme') has become more confusing as it has become more widespread. It is a recent innovation or, perhaps, contraction, which was certainly unknown to Babbage, and I feel sure that Lady Lovelace's father, the Lord Byron, would have turned several times in his Grecian grave if she had used it to describe her activities concerning Babbage's analytical engine. I suppose it to be a shortening of 'to draw up a program,' and to have originated in an organisational context. In this form it implies setting out a sequence of defined operations, and it is in this sense that it is used both with regard to production planning and in connection with digital computers. Indeed, it is only in the field of operations research that the word has ceased to bear so simple an interpretation. 'Linear programming,' for instance, refers neither to programming for computers nor, as a general rule, to programming for production planning, the problems associated with which are usually non-linear.

CONSTRAINED MINIMISATION

'Programming' in this sense usually refers to the mathematical formulation of a problem met with in production planning, which is more properly described as 'constrained minimisation.' Solution of the linear programming problem involves minimising a linear function of a set of variables subject to constraints, which may be formulated as equations or inequalities linear in the variables concerned 'Quadratic programming' is usually used ambiguously, since it is seldom clear whether it involves minimisation of a linear function subject to quadratic constraints, or of a quadratic function subject to linear constraints, or of a quadratic function subject to quadratic constraints. It is not certain that 'dynamic programming' has any clear meaning at all in this context. The term is sometimes applied to the technique of revising a production program sufficiently often that statistical variations in machine shop operation can be controlled and priorities readjusted. This goes back to the production planning definition of programming, but takes into account the day-to-day modifications effected by the works manager and his foremen. In so far as this problem in planning and control can be formulated as a non-linear programming problem in operations research, the techniques used in solving the former problem can be formulated mathematically and applied to the latter problem, thus the name is perhaps appropriate, although the connections are often obscure.

To the computer user, a program consists of a sequence of instructions to the computer, the result of carrying out which will, it is hoped, produce a desired effect. To program is generally conceded to be the action of producing a program. There would be little or no confusion in usage were it not that the computer has become a tool of increasing importance both to the production planner and to the operations research worker. Interpretation of the word now depends more and more upon context, as we draw up programs for linear programming, the results of which are sent to the programming section of the production department.

ORTHOGRAPHY

Nor is this the only confusion that has been generated by the growth of new disciplines. Computer programmers are still divided in this country as to the spelling of the word ' programme.' The late Professor Hartree held that the word ' programme ' is a frenchified version of the Anglo-Saxon ' program,' and that the latter is to be preferred. The reader may, perhaps, already have deduced my early association with Professor Hartree.

Let us now look a little closer into what is involved in sorting a problem using a computer. There are several stages involved. Firstly, formulation; we must define the problem to be solved. Secondly, method; we must decide upon the method of solution. Thirdly, expression; we must express the problem and its method of solution in terms of the apparatus available to us, eg we must prepare a program for a particular computer. Fourthly, preparation; we must prepare the program and any associated data in a form suitable for assimilation by the machine. Fifthly, correction (or, in American, debugging); we must ensure that the program is substantially correct. Sixthly, operation; the computations must be carried out by the machine under the control of a suitably qualified operator. Seventhly, interpretation; we must inspect and interpret the results produced by the machine.

There is no agreement as to how much of all this is programming. Some people would aver that expression, preparation, correction and operation form a specialist field, and that a programmer need only be capable of mastering the techniques associated with these operations.

AUTOMATIC PROGRAMS

Of these techniques preparation involves a skill little higher than that possessed by any normal typist, and operation can be reduced to a routine task by suitable expression of the problem in terms of the machine. It is possible to deploy a limited skill in expressing the problem in terms of the machine, supposing that the problem has first been fully defined and the method selected. Breakdown of the operation into suitable sized chunks, so that not too much is lost should the machine fail, choice of the details of input and presentation, arrangement of the operations within the store of the computer to obtain maximum speed, and a careful sectionalisation of the program, so that each part can be tested and corrected as it is written, will all contribute to the efficiency of the operation. However, this skill is largely mechanical, and standard 'automatic' programs, such as AUTOCODE (Brooker, 1958), FLOWMATIC (Hopper, 1958) and FORTRAN (Backus, 1957) exist which reduce the labour involved in expression, as distinct from formulation and choice of method, to a triviality in many cases. It is true that this facility is paid for in terms of operating time on the computer, but the existence of these programs serves to illustrate that the skill involved is limited.

GOODBYE TO THE CODER

In some organisations the work described above has been carried out by a sort of subclass of programmers, who have been called ' coders.' The existence of a highly intelligent class of coders was greatly facilitated in the early days of computers by the fascination of exploring the possibilities of a new medium. Much kudos can still be obtained among the knowledgeable by the invention of skilful tricks to get the fastest operation or use the least storage space for some detail within the computer. And there are a few acknowledged masters of the art in the United Kingdom, such as D J Wheeler, S Gill, R A Brooker, and C Strachey, although they have all ceased to be primarily ' coders ' in the sense described. Indeed, it may well be that the day of the coder is passing, with the introduction of more sophisticated machine construction techniques and the use of problem oriented languages, such as algebra, to address the computer directly.

MATHEMATICS AND METHOD

The difficult part of problem solution is undoubtedly the formulation and choice of method. This work has, on the scientific side, largely been the province of the applied mathematician, working with the experimentalist whose raw material poses the problem. Research into new methods ought more properly to be regarded as pure—though whether it is pure logic or pure mathematics or pure common sense is sometimes difficult to determine. Be that as it may, many of the greatest mathematicians, from Newton, through Euler and Gauss to Hardy have concerned themselves with numerical mathematics and with the analysis of procedures for evaluation of mathematical expressions, which theme occupies much of the time and effort of University Computing Laboratories today. Indeed, it is due to such research and to the compact and excellent notation of algebra that the development of the use of computers for scientific work has been so rapid in the last ten years.

A S DOUGLAS, BSc, MA, PhD, FInstP, Director of the Electronic Computing Laboratory, University of Leeds

In 1941 Dr Douglas took the external degree in estate management at London University, and then served for five years in the Royal Signals, more than three of them in India and Burma. After demobilisation in 1946 he went to Cambridge to read mathematics and remained there to do research on theoretical physics under Professor Hartree. He worked from 1950-54 on the application of computers to problems in atomic physics and X-ray crystallography. In 1954 he succeeded Dr Gill as Visiting Assistant Professor at the University of Illinois, where he took a considerable interest in computer design. From 1955 until he moved to Leeds in 1957, he was Fellow and Junior Bursar of Trinity College, and carried out further research.

Since 1951 he has taken part in teaching on a series of Summer schools and other courses in Cambridge and in the USA, and, more recently, in Dundee and Leeds.

(Photograph: Courtesy of The Yorkshire Post).

WANTED—A LANGUAGE

However, computers are capable not only of carrying out calculations rapidly, but also of processing data. Algebraic notation is unfortunately not well suited to specifying processing operations. It is, in fact, a language of statements and not of procedures, and, in order to incorporate specification of the mathematical evaluation method to be used, we have been forced to introduce into scientific programs the idea of sequencing these statements, and of repeating these sequences under control of the program. The language used at present to describe this sequencing is primitive, and a language has still to be developed which will command universal acceptance. Until the development of such a language suitable to describing processes to be performed (with or without calculation) upon data, it will not be possible for every systems analyst and accountant to be his own programmer in the way that many engineers and scientists are now. It is well recognised that this development is an urgent task for research workers in the data processing field.

If the days of the detailed coding expert in the scientific field are numbered, his work cut from under him, as it were, by the machine designer, his period of grace is likely to be longer in data processing. Nevertheless, we may look forward to the day when interest in the two fields will mainly centre on the analysis preceding solution. The only programmers will be primarily numerical or systems analysts, or people with training in these fields, dedicated to defining and solving problems in their respective milieus, using the computer where appropriate, or other tools if they are more suitable.

All will need to be trained to use a computer but this training will be simplified. In the narrow sense, programming for computers will no longer exist; in a broader sense, however, it will leave programmers freer to concentrate on the more difficult and challenging side of their work. Until this state of affairs arrives, it is inevitable that some confusion should exist, and that programmers should attain to different levels within the problem solution according to their ability and judgment. There is little doubt that formulation of, choice of method for, and coding of a problem can only efficiently be attacked if they are considered as stages in a complete process of problem solution. The whole solution is recognised as his province by every good programmer, however it may be split down in practice. Perhaps there is no such thing as programming for digital computers that is not already covered by the techniques of numerical or systems analysis. I would rather express it another way and say that programming combines the two techniques of analysis in that proportion necessary to tackle the problems confronting the programmer. It is this cross-fertilisation of two techniques combined with the versatility and capability of the computer which lends programming its peculiar intellectual interest.

AMERICAN REPORT *by Research Department, John Diebold and Associates, New York*

Data Transmission: a key to successful integrated data processing

American users and potential users of ADP equipment are keenly interested in the faster and more flexible facilities for transmitting data which are now becoming available. The benefits to be realised from centralising accounting functions, scientific computing, or data processing are obvious: there are opportunities for managements to obtain a more comprehensive picture of company operations with a minimum time lag, and in scientific applications, for smaller computers to solve lesser problems at remote points and then transmit results to central computer installations. Additionally, more powerful computers could be used economically

CENTRALISED data processing operations with data feeding in from many remote points are operating successfully at present in the USA. However, improvements are needed in equipment and transmission before this type of operation becomes widespread. One of the problems is speed. They are slow in comparison with the tremendous rates at which computers handle information. The second problem is the gap between transmission equipment and the computers themselves. Ideally, we would want to have the least amount of human intervention in a system. Once data are created at the source, they should be transmitted, received and directed to the data processor completely automatically. At present most systems have a gap between the end of the communication's common carrier and the actual processor. Manual processes are necessary, such as carrying punched cards or punched paper tape from the receiving equipment to the computer. In many cases, a separate conversion operation is necessary before the data can be introduced into the computer.

SPEEDS OF TRANSMISSION

The problem of speeds in data transmission is receiving considerable attention by manufacturers of transmitting equipment. The standard speed for transmission over telegraph lines is approximately 60 words per minute. This type of service handles a five-channel code only. The basic voice band is indicated as the most suitable band width for data communication, when the economics of terminal versus line costs are weighed. The voice band can provide speeds of up to 1,000 words per minute; however, such speeds also demand some sort of storage for data produced at slower rates. An important factor favouring voice band data transmission is the widespread availability and flexibility of the communications facilities, since telephone lines enter most of the places where data communication will be needed.

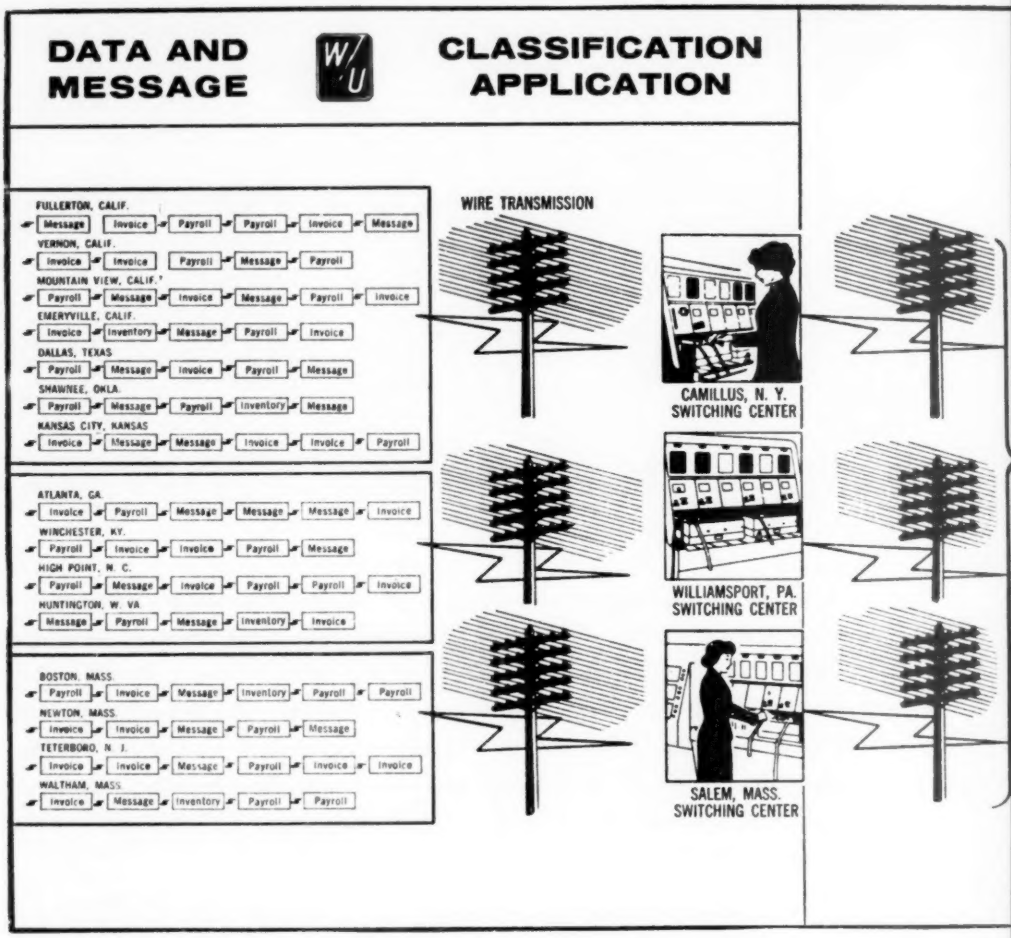


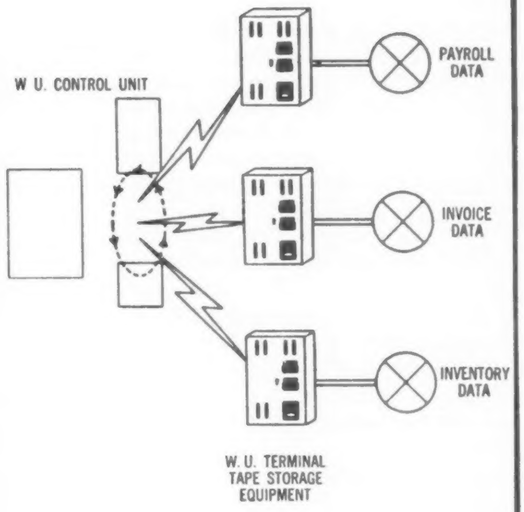
Figure 1 A transmission system developed by Western Union

DATAPHONE

One of the most recent developments of the Bell System in the United States is the Dataphone service which is now undergoing tests in the field. This service includes a digital subset (subscriber's set) which accepts an input of direct current 'on-off' pulses (of any code or language), modulates them (converts them into FM or tones for line transmission) and demodulates them at the receiving end into the original d.c. pulses. This equipment allows the manufacturer of data processing equipment considerable freedom to design his equipment, without having to adhere to telephone company requirements as to codes, speeds, word lengths, redundancy checks and the like.

The recorded carrier subset is another type of equipment available with the Dataphone service. This unit accepts data in the form of bits, but stores the information on magnetic tape until such time as a suitable quantity of information has been accumulated. An operator can then place a telephone call and the accumulated data can be transmitted via the digital subsets at full speed over regular telephone wires. This allows more efficient use of the service since the high speed transmission facility, when used, can be used to its fullest capacity.

Future developments planned include subsets which use a six-wire or twelve-wire input-output circuit. These will be able to accept six-bits or 'three-out-of-twelve' code simultaneously and transmit them in parallel on different frequencies. This development will simplify the job of the business machine designers.



COLLINS KINEPLEX SYSTEMS

Another high-speed transmission system which has been fully developed by the Collins Radio Company, and employed by the US armed forces, but which has not been put into civilian use as yet, is the Kineplex Card Transmission System. This system can transmit 100 fully punched IBM cards per minute over a three-kilocycle voice channel. It provides a parity check for each card and offset-stacks those cards which have errors on the output end of the system.

IBM 523 gang summary punches are used at the sending and receiving stations with Kinecard converters and Collins' modulator-demodulators. Collins also has developed a Kineplex magnetic tape transmission system. It reads and transmits 300 IBM or Remington Rand coded characters per second over a voice-channel facility with full-parity error checking and correction. The receiver converts and checks the parity information before recording on magnetic tapes. Parity errors cause a re-transmission of the appropriate block of data.

Systems such as the above are leading to more practical solutions to the integrated data processing systems which must process data for a country-wide operation. The use of such systems as the Kineplex transmission systems provide data at the data processing centre in a form which can be immediately introduced as input to the computer.

In cases where data are originating at many sources, and consisting of a wide range of length and complexity, classification and co-ordination at the receiving computer centre is important. Usually large volumes of data are involved, but it is not necessary that the computer be interrogated immediately. The data can be accumulated and sent in bulk, thus increasing the need for some method of data classification. The economic considerations here are (1) that the data may be accumulated and sent at high speed to get most efficient use of the communication lines, and (2) that the input to the computer may be scheduled for most efficient use of computer time.

DATA AND MESSAGE CLASSIFICATION

Western Union has recently modified certain of its apparatus so that data classification is provided automatically. The use of this feature has great possibilities for IDP. (See Figure I)

The system can include invoice, payroll, order and production scheduling, and scientific data. The data may originate at hundreds of locations across the country, and be transmitted to a computation centre for classifying and processing. In addition, the system can handle administrative communications (ordinary telegrams). This latter introduces the need for automatic separation of the two: data and administrative messages. At outside stations the same machine is used both for administrative messages and for data.

From the distant stations, data may be transmitted in a somewhat random manner—i.e., one station may have a lengthy transmission of one type of data, but other stations on the same or other circuits may be preparing some other type of data for transmission. Administrative messages may be interspersed with data transmission. In some cases, administrative messages will be routed from one or more of the minor switching centres to the final destination, with a minimum of this type of traffic entering the site where the computer centre is located.

At the processing centre, each circuit used for data processing terminates in a receiving perforator

(paper tape receiver). Messages are received here on perforated tape feeding continuously through a transmitter which will be connected automatically to the correct final position for each particular type of data. Thus, this transmitter will recognise, say, invoice data, be connected to a perforator and transmit the signals to this perforator allocated for invoice data where the received tape will be wound on a reel for computer processing. Each kind of data is similarly accumulated on separate reels for its particular type, regardless of the order in which it was transmitted to the computer centre. However, administrative messages are automatically separated and appear elsewhere on the premises for delivery or further routing.

Automatic message numbering as it is transmitted from an outlying switching subcentre provides complete system-wide protection from loss of messages, as well as efficient reference control. In the heading of each message are control characters to indicate which kind of data follows. At the centre, during re-transmission to the receiving position mentioned above, equipment checks the automatic number for proper sequence and checks certain of the heading character signals for accuracy. In this way, large masses of data may be received in random fashion and unscrambled at destination according to type.

DATA TRANSMISSION IN A SCIENTIFIC INSTALLATION

It is not only the business data processing applications that benefit from the use of data transmission facilities. A large oil company which has been making use of electronic computing equipment since 1954 is now maintaining a central large computer centre for scientific applications using an IBM 704. Several of the company's research laboratories have medium scale equipment but some of their problems are of such large scope now that the use of the large computer is quite beneficial.

An IBM Data Transceiver system has been set up between the central office and one of the research laboratories. Other laboratories are expected to be hooked into the system shortly. The Data Transceiver System consists of a send-receive unit at each station. These units read and punch IBM 80-column cards at a rate of approximately three to five cards per minute over telegraph lines and at the rate of approximately eleven fully-punched cards per minute over telephone lines. Higher speeds can be attained if the cards are not fully punched. Transmission is direct from card-to-card without the use of paper tape and checking circuits ensure a high degree of accuracy. If additional terminal units are used, up to four independent transmissions can be made simultaneously over the same telephone lines.

Under the present procedures at the central 704 operation, a standard of two hours has been set up for the time within which to get answers back to the sender. Applications on the 704 are not contemplated to exclude use of the present local computers, but are confined to those which are best done on the larger, more powerful equipment.

With the 704 as the hub, the network is already saving time and money for the company. Often, one of the medium size computers will initiate a problem and then send it on to New York for the large computers to complete. It is more economical to let the local computers work out partial answers, and then let the 704, which is approximately 50 times as fast, come up with final solutions.

A very important aspect of such a network as described here is a standard communication system between the central operation and its users. The system used here has formalised rules for procedures. The remote unit must send to the central office:

1. a priority list showing in what order its problems are to be run;
2. operating instructions for each task to be performed by the centre: these may be transceived to the central office, but it is preferable to have these instructions mailed to the centre on the appropriate forms;
3. messages directing that changes be made. These are normally used for programme modifications before or after the debugging run on the 704.

The central office must in turn deliver certain information to the remote offices. These are:

1. An immediate acknowledgement of each message received.
2. Immediate reports of changes of jobs in progress. These let the programmers in the remote points know how their job stands, inform them as to where the programme did not function as expected, or give them the answers received at some significant intermediate points.
3. Transceived, teletyped, or mailed results.

For all the above information there must be a standard card numbering system which will indicate to which job each card belongs and a sequence number within the job.

In straight production jobs, the punched cards received over the transceiver network are normally converted to magnetic tape for input to the computer. Output from the computer will also be in the form of magnetic tape. Depending on the type of problem and answer, the tape will either be converted to punched cards to be sent via the Transceiver or the tape will be mounted on a high-speed, 500 line-per-minute printer to produce

a listing of the results. In some cases both the printed and punched card results will be prepared.

DIRECT COMMUNICATION WITH COMPUTERS

In most data transmission installations, exclusive of airline reservations and similar 'interrogation' systems, a distinct and incongruous gap is apparent with the handling at the central computation centre of the data communications network on the one hand, and the electronic data processing equipment on the other. This gap is being closed in what is now a special purpose configuration that undoubtedly will eventually be modified to commercial application—namely, the Univac computer system in air traffic control being furnished by Remington Rand Division of Sperry Rand Corporation to the US Federal Aviation Agency. Portions of the system have just been placed in operation at linked facilities of the New York Air Route Traffic Control Centre at Jamaica, NY, and the National Airport in Washington. They will presently be tied in with computer facilities in Cleveland, Boston, and Pittsburgh.

The input equipment makes possible the automatic connection of several perforated tape network circuits to a single demand station of the computer. The output equipment similarly allows connection of a single demand station of the computer to any one of several outbound perforated tape communications lines. Also, the computer has capacity for a number of these complete complexes for installations requiring more than 16 inbound lines.

Input traffic is received from the carrier service at, say, 75 words per minute. The carrier's receiving 'staticisers' change the reception from serial code to parallel code for presentation to one of as many as 16 input substations. Each of the latter consists of a low-speed paper tape punch (LSRP) unit, a loop storage device, and a high speed reader-transmitter (HSX). The multiple substation configuration is connected to a single scanning device.

The paper tape punched at each of the substations is stored as a loop until a complete message has been accumulated. On receipt of an 'end of message' code, a signal is sent to the input-scanner unit.

The input scanner continually scans the substations in sequence, and as soon as it finds one ready, it 'seizes' the HSX and reads the message into the computer, through a high-speed paper tape input-output (HSPT-I/O) unit, at the rate of 60 characters a second, or 600 words per minute—eight times transmission speed.

The scanner sequentially services each substation which desires to communicate with the computer. Scanning is at a very high rate of steps per second. Elaborate error checking features are included.

The first section of the HSPT-I/O unit is a 'translation and format control' unit; the second section is the computer input/output control.

The output system is similar to the input system, with sequence in reverse: messages go via the HSPT-I/O through a unit comparable to the input scanner, called a 'distributor', to a selected output substation. Here, as opposed to the input sequences, the configuration is high-speed paper punch (HSP) and low-speed transmitter-reader (LSX). Minimum punching rate of the output punch is 60 characters per second, and as many as 16 output substations can be serviced. The high-speed punch provides a means for the computer to pass on its message and attend to others, without the constriction which the actual transmission line speed would impose. In other words, the output substation provides buffer storage in the form of punched perforated tape to serve as a speed transition barrier between the high speed computer output and the low-speed perforated tape network transmitting equipment. Carrier-supplied 'serialisers' change parallel to serial code for transmission (paper tape hole or no-hole combinations arranged in a sequential train).

The distributor will choose automatically the outgoing route to be selected, as directed by the computer. Each of the 16 possible transmission lines has one or more destinations. The computer 'steps' the distributor to the particular substation associated with the line which serves the destination of a given outbound message. (The input scanner, of course, does not have this problem; every message has but one destination: the computer).

The multiple-destination-per-line problem is solved by the computer's perforating the particular destination on the substation's paper tape, from whence the common carrier's selectors make the required individual selection.

This entire complex—input and output—automates the heretofore manual gap in otherwise automated systems.

THE FUTURE OF NETWORK ADP

The foregoing represents the current operations and forward planning of remote-data processing. Looking farther into the future, it will not be too long before individual companies will have reached the economic limits of time sharing on their own. It is not too far fetched to foresee the time when companies within a given industry will have to pool their resources and install the ultimate in large-scale, powerful computers on a regional basis, for all to use, with operation by an independent subsidiary to protect data privacy. At that point, the lessons learned in intra-company time sharing will be put to the final test in effective inter-company computer operations.

Names and Notes by Robot

An Electronic Eye on Delinquents

THE radio and television rental organisation, DER Ltd, have lodged an order for an Electronic Reading Automaton (ERA)—a machine which will 'read' directly information on cash register tally rolls and punch this out onto punched cards.

The machine is not due for delivery until early in 1961—but this, the company explain, accords well with their plans for reorganising their data processing setup.

The principal accounting task that DER face is that of ensuring that customers who rent radio and television sets do in fact pay their rentals.

With branches in most of the large towns in Britain at present the company check on customers at two accounts offices—one located in Sheffield and the other in Twickenham, Middlesex. The Twickenham office which makes use of a small 40-column card installation, receives regularly records of customer's account number and the amounts paid. This information is punched manually onto cards, so that by a process of elimination in the punched card department (by comparing 'payments due' with 'payments made' cards) the company can keep track of 'delinquent' customers who fall behind in their payments.

Inevitably, in this setup where cards are punched manually, errors do occur. Punching errors may result in customers receiving reminder notices which do not apply.

Even if the error rate is only one percent, the company explain, this could nevertheless result in offending some thousands of customers each year. In the rental business, where a product is not *sold* but retained by mutual agreement, income is directly geared to giving the customer satisfaction and retaining his good will.

When installed, the ERA machine should overcome the present incidence of error. It will, in fact, be the hub of a new system of rental accounting. Each DER branch will be equipped with specially-designed National cash registers which will enable assistants who receive payments to print onto tally rolls such information as a customer's account number and the rental payment amount. These tally rolls will be sent to Twickenham, where the reading automaton will scan them and punch out the data on 80-column cards at the rate of 6,000 cards an hour.

It is at present uncertain whether the Sheffield accounts office, which now does its rental accounting manually, will send data to Twickenham to be processed there. Solartron—the manufacturers of ERA—are at present examining on DER's behalf the possibility of relaying over landlines data read by ERA in Twickenham, so that cards could be punched automatically in Sheffield.

Justifying a £40,000 Investment

DR HENRY DURANT of Social Surveys (Gallup Polls) Ltd has got his eye on St George's Day—April 23 next year—when a National-Elliott 803 computer will be delivered to the company.

DR DURANT admits quite freely that one consideration in opting for this particular machine was the early delivery date, for Social Surveys have an acute data processing problem.

Noted for their political public opinion polling, the company's activities in fact embrace far more than this: market, advertising, television and retailer research. At any one time hundreds of interviewers scattered throughout the country fill in questionnaires about people's preferences for political parties, newspapers, or products. These questionnaires can be quite formidable documents—some with as many as forty main questions to be posed and a host of possible replies. When enough questionnaires have been compiled for a particular task each interviewer sends in his batch to Social Surveys' headquarters in Regent Street, London.

The next stage is to punch information from the questionnaires onto punched cards in order to be able to tot up mechanically the number of replies given to various questions. Usually information

on one questionnaire can be entered on an 80-column card; sometimes two or more cards are required.

To count the various replies automatically the company presently employ two electronic statistical machines which can read five columns (or 60 replies) simultaneously and which print out totals after a run of cards. However, as Social Surveys use most of the columns on a card, a pack of cards may have to be run through 200 times.

This and the fact that the totals produced on the 'counting' machines are absolute totals, necessitating a further and manual task to obtain percentage totals—25 people may be employed using slide rules on some occasions—explains why over half the time required to produce an average market research report is spent processing data.

The company's present equipment is being worked flat out every available moment so that it is not surprising that the company have been looking into computers for some time.

When the 803 machine arrives punched cards will still be prepared from the questionnaires, but it will then be possible to have all the data read into the computer *in one run* as the computer will be able to store all the information on the cards, acting, as it were, as a multiple register.

The results—absolute and percentage totals for various items of questionnaires—will be punched onto paper tape, which at the next stage will be used to prepare the reports on two Flexowriter machines. In fact, with a little form preparation done beforehand it should be possible to get straight from the Flexowriters the reports in their final form.

Social Surveys reckon that their 803 will be initially employed six hours a day on their own data processing. Later work may be done for some of the continental Gallup companies on a service basis, and indeed any other company.

I asked DR DURANT if Social Surveys could justify (economically) the purchase of an 803, which markets at around £40,000. He had two straightforward replies to this probe: first, a market research report which at present takes the company six weeks to prepare would, once the computer was operating, take three weeks to complete; secondly, the company's present equipment is being rented at a cost of approximately one-seventh of the computer's price so that at present rental charges the computer could be written off in seven years.

Normally, the company's research work does not involve the use of complex statistical techniques so that all the company require for most of their data processing is a general-purpose programme. This is being written for them by Elliott's—though of course, Social Surveys will send three of their staff on a programming course next month.

For HP Sales Only

LAST month Montague Burton Ltd, the multiple 'tailor-of-taste' firm, opened their doors to receive a £50,000 ICT 1202 computer. Burton, who have used punched card equipment for several years, have bought this machine, not as a natural extension to their present card set-up, but for a specific job: to control credit sales made through the firm's 600 retail branches. Burton, late-comers to the credit-sales business, will use the machine exclusively for this control function.

Planning and ADP

AMONG the ten University Extension lectures on 'Computers in Commerce and Industry' arranged by London University's Extra-Mural Studies department this autumn, there was one in particular that I wanted to hear—on Computers and Economic Planning.

Prepared to be told a great deal about 'optimal planning,' wistfully I also hoped to hear of concrete examples of its application and with perhaps firm estimates of their value thrown in.

It would be churlish to tax the lecturer—Mr G S GALER of the Economics and Planning department of the Shell Chemical Company—for not giving me what I wanted. It was, after all, mostly a pipe dream.

Correctly, Mr GALER relegated the electronic computer to a monster calculating machine, and concerned himself with explaining the type of problems economic planning was concerned with, and the techniques evolved for their solution.

Starting with a hypothetical plant which produced a product 'Blonco' but in three forms (*a*, *b*, and a blend of *a* and *b*) and by making assumptions as to the cost of making various quantities of the product in its three forms, their demand and selling price, he demonstrated that there could be several production alternatives giving varying profits, and that with linear programming and parametric linear programming techniques, it was possible to work out the *most profitable* production plan to follow.

This sort of approach—essentially an operational research one—is well known to the experts, though refinements are continually being evolved; but what I did not realise before is that this kind of 'optimal planning' could be done on a regular basis. Schooled to think in terms of OR techniques as being capable of providing a solution to, for example, a stock control problem *once and for all*, I confess that I have overlooked until now the

continued on page 31

Rigid staff function policies coupled with perfectionist disciplines and procedures are insisted on in this computer service department

THE STRESS ON ACCURACY

AT ROLLS-ROYCE

By KEITH BEAN

EXACTING in the building of their engineering products, Rolls-Royce have likewise to insist that the processing in their computing organisation is one hundred percent accurate. Processing is strictly controlled for accuracy right from the reception of originating documents to delivery of the job. It also aims to use its machinery—two IBM 650s and much peripheral equipment—to maximum efficiency.

To achieve these objectives, recruitment of high-standard staff and rigid disciplines are the rule.

The chief computing engineer, Mr L Griffiths, has a staff of 50 and each section—programmers, computer operators, punched card machine operators, punchers and verifiers—is tightly confined within its own sphere. Programmers, for instance, never operate the computers except when they need to test programmes they have written.

SPHERES OF WORK DEFINED

The work of the computer office is strictly on the closed-shop principle. All programming, operating and the control of the flow of work is handled entirely by the computer office.

'We are strongly of the opinion,' says Mr Griffiths, 'that if we were to work on an open-shop basis then the efficiency and quality of our programmes, the efficiency of our machine usage, the maintenance of programming and operating standards and our rigid control of accuracy would all suffer considerably and, further, the cost of processing would go up considerably.

'We estimate that our costs for magnetic tapes alone would increase by about £60,000 if we were working on an open-shop principle.'

Of four groups in the programming section, which employs a staff of 24, one applies itself to financial and production control applications and the other three to technical applications. One of these latter, the numerical analysis group, handles all the work which involves advanced mathematical or numerical analysis techniques. It is in fact a service group to the other programming sections and to the company's technical departments in general. Every effort is made to ensure that it handles only work which is of an advanced mathematical nature and then only on the first occasion any particular type of problem arises; thereafter the work is passed to one of the other programming sections.

In addition, one programmer is solely concerned with the development of routines and the more sophisticated programming aids.

HONOURS GRADUATES ONLY

All programmers hold an honours degree in mathematics not because that is considered essential, but because it is thought, with its logical training, to give a certain guarantee of recruiting potentially successful programmers.

A programmer is responsible for a job from its inception until the programme is fully tested and ready for production running. Before he begins on a new application the 'customer' department's people give him a full understanding of the job—why they want to do it, what they hope to get out of it and the theory behind the job.

The customer department also provides a completely detailed request report which contains a precise statement of the problem, the input data that will be available, a complete specification of the output required, details of the ranges of numbers involved at each stage, a check calculation for programme testing and, where practicable, an indication of possible future extensions to the programme. Besides the obvious advantages for the programmer, this also ensures that the customer department has given full thought to the work it wants computing.

In commercial applications, the programmer is attached to the methods study investigation—again to ensure that he has a thorough understanding of the work.

When the programmer has arranged the job in logical form suitable for the computer, and before he starts programming, he draws out a highly detailed block diagram. For the first year of the 650s' operation all programmes were coded in machine language. The use of SOAP* and other programming aids were banned in order that programmers would gain greater understanding of the machine logic.

'Most programming is now in the language of SOAP II or IIA, but we have reaped the reward of this very close understanding of the computers, which our better programmers have gained, in obtaining highly efficient subroutines, routines and sophisticated procedures to an extent that could not have been achieved in any other way,' says Mr Griffiths.

Programme test periods are now normally automatic, performed by computer operators with automatic testing routines, but programmers are allowed to go to the computers for final manual testing. Console button-pushing and the thinking of alterations to the programme while at the console are completely forbidden.

When a new application has been completely tested, its programmer produces a computer programme report which contains a précis of the theory of the job, computer operating instructions, the punched card forms involved, a copy of the programming block diagram and a copy of the programme itself.

Wherever possible, standard programming procedures are adopted, contributing to simpler computer operation and therefore tighter control of accuracy. Programmers are expected to follow them in all their work. One example is the list of standard stop codes with which all the computer operators are familiar. It contains a code for every type of detectable error for which it is necessary to stop the computer during production running. It saves a lot of waste in computer time.

COMPANY TRAINING

The company trains its own programmers—on an initial three-month course during the last month of which the trainee can turn out simple but productive programmes. All trainees spend the first two weeks learning about the conventional punched card equipment—punches and verifiers, sorters, reproducers, collators, interpreters and tabulators—and are expected to acquire reasonable familiarity with their operation and with the wiring of associated plugboards. They will never be called upon to operate a conventional machine, but this training is considered essential so that they can arrange their computer input/output to the best advantage of computer and conventional equipment.

'Our programmers are usually very proficient at the end of the three months but we find it takes about 18 months for a man to become a really first-class programmer, assuming he has the ability,' Mr Griffiths said.

The computer operating staff of ten men is divided into teams which permit computer operation 24 hours a day, seven days a week. Their qualifications vary between advanced GCE and university pass degrees.

DIAGNOSTIC TRAIL

'We expect our operators to understand programmes—they are taught programming in their initial training,' said Mr Griffiths. 'We encourage them to acquire a basic understanding of each job, which gives them a high degree of confidence and interest in their work and promotes a better operating standard. We also expect them to give a clear diagnostic trail to the maintenance engineers in the event of machine fault.'

One of the computer organisation's fundamental aims is to reduce operator interference to a bare minimum. Programmes are written which will, on detection of an error that will not affect the whole job, automatically produce a trail card with standard error indications, and go on to process the rest of the work without stopping the com-

* SOAP: Symbolic Optimum Assembly Programming.

puter. If the detected error would adversely affect the job's output, the programme stops the machine with a display of the appropriate standard stop code which tells the operator whether he should take the job off the computer or how to take remedial action on the spot.

In addition to the commercial punched card installations, which raise the cards for commercial computer runs, the computer room has its own punch and verifier section.

ONE ERROR IN A MILLION CARDS

Seven of its staff are permanent punch operators, four are verifier operators and one is an error corrector. Every card punched is verified. When a verifier operator detects an error, the error corrector punches a new card and passes it back into the system for verifying. If a verifier operator fails to detect a punching error she ceases to be a verifier operator and is transferred to punching. Weekly statistics show the number of holes punched and verified by each operator and the number of errors undetected by the verifiers.

'With such procedures we maintain an error rate on the output of our punch and verifier room which is as low as one error in approximately every million cards raised,' said Mr Griffiths, 'and in practice we find that this error is usually detected at a later stage in processing or before we pass the job to the customer department.'

Scope For Future Work

As with many precision-made products, the manufacture of aero engines involves much difficult tooling. Rolls-Royce has installed in one of its tool rooms a Ferranti automatic milling machine and a Newall automatic jig borer which can also 'staircase mill.' They are a big step forward but they present problems.

They cannot 'read' engineering drawings nor indeed can they accept data in the form in which it was previously handed to the operator of conventional equipment. The form of input needed and the accuracy required preclude the use of manual calculations even for comparatively simple examples. The computer office has produced a number of fairly general purpose computer programmes which will, starting from a minimum of information taken off the engineering drawing, provide the machine tool with detailed control information on a suitable input medium.

Although each single facility provided in these programmes springs from simple trigonometry or geometry, great organisational difficulties are encountered in making the programmes sufficiently general to provide for every possibility or combination of possibilities without giving the tool room planner too complicated an input form to supply to the computers.

The existing machine tool programmes are largely for two-dimensional shapes but work is in hand on programmes which will supply the automatic machine tools with control data for the milling of compressor and turbine blade model die blocks—which are defined by quite complicated three-dimensional surfaces.

The computer office is also developing interpretative programmes which will allow the tool drawing office and tool room personnel to supply their planning information as input to the computers in basic English, so removing the irritation of abbreviations and somewhat meaningless codes hitherto imposed on them.

Mr Griffiths, Roll-Royce's chief computing engineer, had such developments in mind when he said: 'There are still hosts of ways in which we can improve our service and there are still a lot of challenges to be met and overcome.' As examples, he listed:

- perfection of non-linear optimisation techniques—to be applied first to aero-engine performance work but eventually to be adapted for other engineering projects and for commercial and production control procedures;
- powerful and sophisticated supervising control programmes particularly suited to this (Rolls-Royce) environment;
- development of data transmission equipment that will meet the requirements of speed, error detection and error correction;
- mechanisms and procedures that will bring in data from a very large number of points in the factory quickly, economically and with guaranteed accuracy;
- programmes which will permit the automatic satisfaction of a number of engineering functions, which may be conflicting, on a part or component in one run through tne computer;
- more powerful general utility and programme testing routines and the derivation of improved numerical techniques;
- automation of test stands to provide the instrument readings directly on computer input medium.

'These,' he said, 'are just a few areas in which we plan to spend a considerable amount of effort. These projects plus the enormous task of transferring our large volume of IBM 650 applications and developing new procedures for the IBM 7070 will provide us with fascinating and vital work for a long time to come.'

The same minute attention to detail applies in every stage of the data processing. Exhaustive programme checks are built in to prove the validity of the computer operator set-up and to check the input of cards and tape.

'It may appear that we are over-cautious but experience has taught us that not one of our controls is redundant—every one of them has at one time or another played its part in maintaining our error-free record of work turned out of the installation,' said Mr Griffiths. 'We have always been extremely thankful that we spent considerable time and effort planning them before our existing equipment was installed.'

With similar thoroughness the computer office has its fully automatic book-keeping system which accounts for every minute of machine time. It provides a detailed weekly analysis of utilisation of computers by jobs and originating department, a cost analysis which informs the customer departments of the time and money spent on their work and a machine utilisation total which is used to determine the rental due on the equipment.

Such detailed control gives Rolls-Royce a solid basis for the assessment of the computer installation's worth. But their enlightened computer men are still exploring further ways of exploiting the computers.

Weight Control by Punched Cards

Linking punched card equipment to sophisticated weighing machines has provided the food and process industries with powerful systems for controlling production

BASICALLY, the weighing machine is a just arbiter between buyer and seller. Its history goes back at least 6000 years, and its design development has ranged from the simple even-armed beam, through the Roman steelyard, simple and compound lever mechanisms with steelyard indication, to systems with dial indications and dial recorders.

The application of weighing has also broadened. From the simple transaction between buyer and seller, development has kept pace with industrial progress, and scales are now widely used for purposes of production control; but the wonders of yesterday are commonplace to-day, and recent developments in electronics—and particularly of the computer—have enabled the well-known scale makers, W & T Avery Ltd, to develop dial scales to link up electrically with one or more of the available types of business machines, which are designed to provide more information in less time than has ever before been possible.

So much so that scales can now be operated by punched cards or punched tape, and record their weighings on punched cards, punched tapes, listing and adding machines, and electric typewriters, in any combination. Invoices, receipts and other

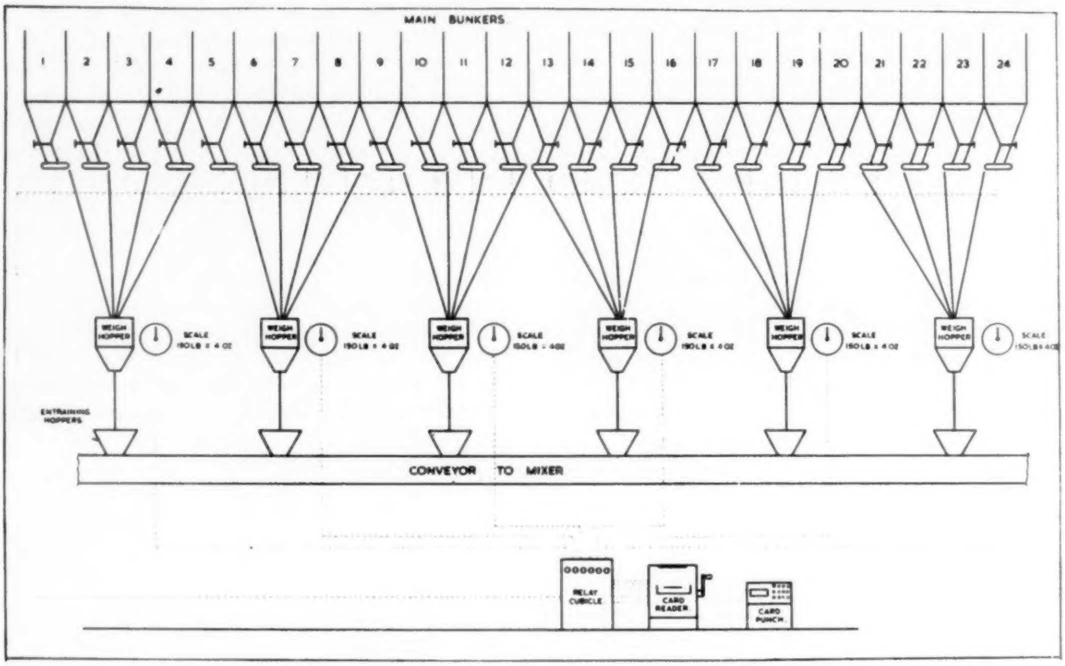


Fig 1

documents can then be produced automatically by processing the punched cards or tape through a tabulator.

The following examples indicate the possibilities of this weight control system, bearing in mind that much simpler applications of the principle are possible.

INPUT CONTROL BY PUNCHED CARDS

Figure 1 illustrates an arrangement for batching a large number of ingredients, such as grains and meals used in the production of animal foods.

Twenty-four storage bunkers hold the various materials. A total batch is approximately two tons, and output is four to five batches per hour.

Each of six scales is served by four controlled feeds, short length belt conveyors being used.

Operation is fully automatic under the control of a punched card, which is pre-punched according to formula. The arrangement is such that any number of materials up to the maximum of 24 can be used in any one mix.

On the punched card are six columns, one for each scale. Each column is capable of settings up to 150 lb. by 1 lb. increments for the capacity, and also up to double figures for the number of tips per scale.

The punched card is inserted in the card reader, and a lever is depressed to initiate the sequence of operations. When the complete batch has been discharged into the conveyor, a signal is given, showing 'Batch complete.'

The batching can then be automatically repeated on a signal from the mixer, or operation can be suspended for a new punched formula card to be inserted.

OUTPUT CONTROL THROUGH TABULATED RECORDS

Figure 2 illustrates an arrangement for weigh-batching ingredients stored in four groups of storage bunkers marked A, B, C and D.

A group comprises			12 bunkers		
B	,,	,,	10	,,	
C	,,	,,	4	,,	
D	,,	,,	4	,,	= 30 bunkers

Groups A and B are each served by a travelling Avery dial hopper scale of 10 cwt. capacity, fed by screw conveyor, and incorporating an Avery Analogue generator, the output of which is used in conjunction with a relay cubicle and tabulating machine.

Group C is served by a stationary hopper scale of similar capacity, fed by air slide, and with similar printing facilities. Group D has the same arrangement, but the scale is of one cwt. capacity.

Each feed unit has a separate start button and code number. The start button is electrically connected to the tabulating machines so that when it is pressed the correct code number is printed.

Each travelling weigher (groups A and B) discharges on to a separate conveyor feeding No. 1 and No. 2 mixer respectively. The stationary weighers (groups C and D) discharge into holding hoppers from which the ingredients are drawn at a controlled rate to No. 1 and No. 2 mixer respectively.

All discharge operations are hand-operated, but only after push-button release of a locking device, which is fitted to prevent discharge until the weight has been printed. This is achieved by the action of pressing the release button. It is possible for the discharge from A, C and D groups, or from B, C and D groups, to be simultaneous, a memory device enabling the tabulating machines to register three discharges at the same time.

The total weight of each batch can be obtained, and the grand total weight at the end of a shift.

INPUT AND OUTPUT CONTROL BY PUNCHED CARDS AND TABULATED RECORDS

Figure 3 illustrates an arrangement for weigh-batching, ingredients being drawn from 24 storage hoppers, with an Avery scale serving each hopper.

For punched card control the cards have 24 double columns numbered to indicate the storage hoppers, each column providing for punching, up to double figures, the number of tips required from each scale.

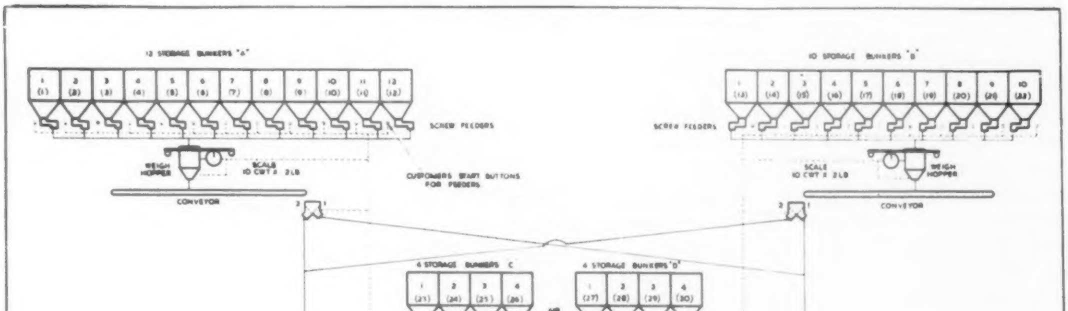
A card punched according to the batch formula is inserted into the Card Reader and a push-button pressed to initiate the cycle of operations. All the scales affected by the formula will start to operate simultaneously, being charged and discharging until the required number of tips is completed.

A signal lamp is illuminated when all scales have completed the operation.

A remote tabulating machine provides a printed record of the number of tips made by each scale, and a code letter or figure identifying the storage hopper.

A control cabinet, common to all scales, incorporates the sequence control gear, push buttons and signal lamps. It includes visible diminishing indication of the number of weighings prior to comple-

Fig 2



tion, by each scale, thus giving a zero reading at completion.

Interlocking mechanism prevents operation until a card is inserted in the Reader, and also prevents the removal of a card while weighing is in progress.

Hand setting controls are provided for use in emergency.

RECORDING DELIVERIES ON PUNCHED CARDS

Figure 4 illustrates an arrangement designed to provide to a central computer station complete relevant information regarding each consignment of field produce—sugar beet—including the computed weight of clean beet and the sugar content.

Two Avery weighbridges and two bench scales, all with dial indicators fitted with Avery analogue generators and digitisers, capable of transmitting an electrical signal proportional to the weight indication, were necessary to achieve the desired results.

Sequence of operations. Loaded lorries are weighed for gross weight, which is automatically recorded on a punched card (1), on which the serial number of the consignment and the date are also punched.

Samples are removed from each lorry, which is then unloaded and weighed on the tare weighbridge, the tare weight being automatically recorded on punched card (3), together with information as to grower, contract number and haulier, transferred from a previously punched card (2).

At the same time a remote electric typewriter automatically prints all the information on a receipt slip. Card (3) is used later for central computing purposes.

The sample of dirty beet removed from the lorry is weighed on a bench scale, which records the weight on a punched card (4) this having previously been punched with the factory number, consignment serial number, date and card number.

After the sample is washed, topped and counted,

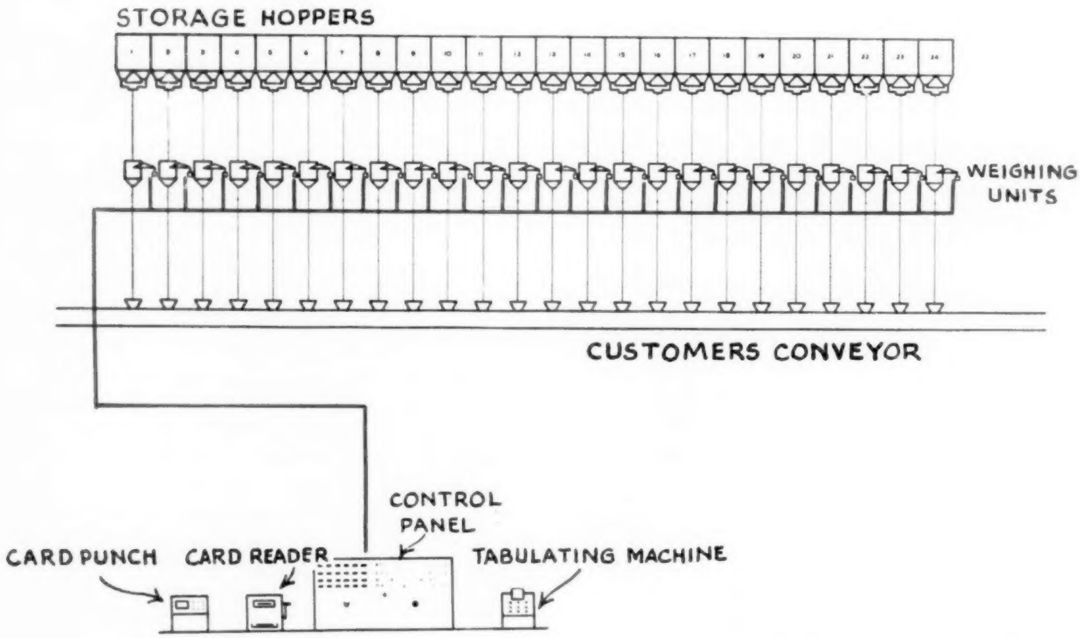


Fig 3

it is again weighed, punched card (5) recording the 'clean' weight. This card also is pre-punched with factory number, serial number, date and card number. The number of roots and the weight of tops are keyed in by hand.

Finally, a sample is cut from the clean beet and tested for sugar content. This information is hand punched on card (6).

So that each card can be correctly related to the other five of the same consignment, a serial number is punched into each one, by means of a plastic code tab which is allocated at the "gross" weighbridge and travels round with the consignment through all stages. At each card punching stage, interlocks are arranged so that the card puncher can only operate when the plastic code tab is correctly positioned in the equipment.

Punched cards (3), (4), (5) and (6) are ultimately processed through a tabulator for costing and invoicing purposes.

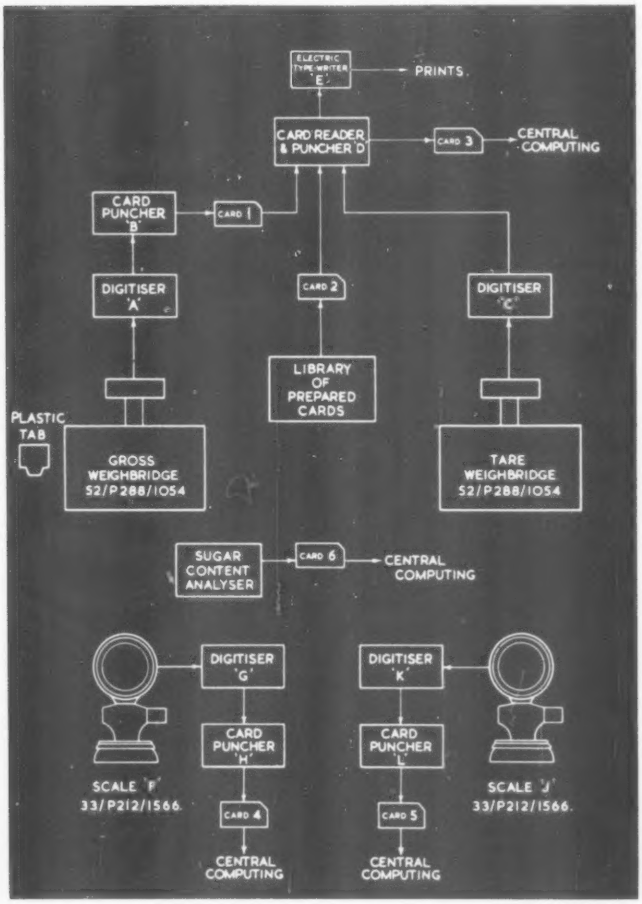


Fig 4

Names and Notes

—CONTINUED FROM PAGE 23

possibility of having a computer programme written for 'optimal planning' in continual use—to devise continually, in fact, the most profitable production plan as raw material and production costs, selling prices, demand, etc, vary. At this point economic planning and automatic data processing are knit much closer together.

New Tricks for Engineers

ONE feature common to all firms in the computer and data processing equipment business is their need to educate the would-be customer: he has first to be tutored in how electronic business machines can be used, and then, at a later stage, on how to make them perform.

Education is a prerequisite to selling.

The same is true in an allied field like the automatic control of machine tools (and, by contrast, if there is less educational activity in a field like Operational Research, that is because it lacks a saleable commodity with firms to push it).

I recently looked in on an introductory course on numerical control systems and programming techniques held by EMI in Hayes, Middlesex. Slanted to acquaint students with EMI's control system, the course combined the business of what the system did with how it operated.

What emerges from a cursory sampling of the course (I could only spend two days *in statu pupillari)* is that the accent is placed on how the system works: to explain the techniques used and the problems involved in, for example, automatic positional and contouring control, going into some detail. Inevitably this involves mathematics—this was clear in the first ten minutes—in particular trigonometric calculations. This is no obstacle to trained engineers, for whom this course is intended (though engineers long out of college may not immediately recall the mathematical properties of a parabola and, wisely, the course recaps briefly for them), but it does mean getting very firmly to grips with new concepts.

My own interest in the course was not in the box of electronic wizardry but in finding out how a punched paper tape was prepared from an engineering drawing: I learnt something of the principles for doing this, and further that they could be boiled down to practical rules of thumb, so that a teleprinter clerk, unversed in trigonometry or analogue systems, can be made to punch a numeric code onto paper tape.

Data Digest

Can Computers Talk?

L E S Green, E C Berkeley and C C Gottlieb: CONVERSATION WITH A COMPUTER Computers and Automation. October 1959. Vol 8 No 10 (USA)

ABOUT 1938, A M Turing said that a computer could be said to 'think' if it could carry on a conversation with a human being in another room in such a way that he could not know that he was talking to a machine.

The challenge was taken up in December 1958 by Edmund C Berkeley, editor of *Computers and Automation*, with C C Gottlieb of Toronto University and L E S Green. The first program ran in April 1959, with 'a surprising degree of success'; a still more satisfactory program was run in August. Results were reported by Green and Berkeley at a meeting of the (American) Association for Computing Machinery on September 2.

A preliminary program for a computer to talk about the weather was written for an IBM Tape 650. The following assumptions about 'the nature of the problem of conversation' were made:

1. Conversations consist of groups of words.

2. In any conversation, a reply to a remark is generated by the meaning the remark has for the person spoken to, the environment in which the remark is made, the experience of the person responding and by interactions among these three factors.

3. In conversations about the weather, remarks are mainly stereotypes.

4. A word or phrase has meaning only if it produces an association with past experience. Words which evoke no associations are meaningless.

5. Words may be classified into three types: 'ordinary' words which have meaning in isolation, eg 'snow'; 'time' words, such as 'October' or 'last week'; 'operator' words, which have no meaning alone but which alter the meanings of other words in context, ie they have function rather than meaning. An obvious example is the word 'not.'

CODING

Meanings were represented in the program by coded pairs, the first figure representing the degree (of intensity) of meaning, the second figure the quality. About 300 words were stored in the computer memory.

A program example is given of the remark: 'I do not enjoy rain during July.' Numerically coded, this reads: (0,0) (0,0) (3,14) (3,11) (6,1) (0,0) (8,9). The non-zero pairs represent the significant words 'not enjoy rain July' which the computer modifies to 'dislike rain July.'

This combination of qualities causes the program to compute the degree of interaction between the weather in the remark (rain) and the weather associated with July (heat, blue skies) and finds that they disagree. The program now selects a reply frame corresponding to the qualities represented by the factors: rain, dislike, July, statement (not question), disagreement. The corresponding reply frame in the memory is: 'Well, we don't usually have . . . weather in . . ., so you will probably not be disappointed.' The program fills in the blanks with words from the original remark: 'rainy' and 'July.'

Part of a sample conversation between Observer and Machine runs:

O: Did you enjoy the rain we had this afternoon?

M: Not really, what I like is sunny weather.

O: In hot weather one needs at least one bath every day.

M: Yes, I was just out and it was sweltering.

O: When Christmas comes we will have some colder weather.

M : Cold? Yes, it's usually pretty frosty during December.

O : Today is clear weather. Will it last?

M : Let me have no lying. It becomes none but tradesmen. Now how can overcast weather and the clear day you mention co-exist?

O : Do you think atomic weapons testing affects the weather?

M : Your query is an interrogation of no consequence to me. However, how do you feel about today's rain?

GOOD RESULTS

The program contains about 800 instructions, makes about 200 decisions, contains 319 words in the recognition vocabulary, and has 350 reply frames into which it inserts about 75 words, using 17 parameters of meaning. It takes about 20 seconds to generate a reply.

In spite of the crudity of the program, 'the results in passable conversation are surprisingly good, which in a way is a commentary on the shallowness of ordinary conversation about the weather.'

Analysing an Opinion Poll

Editorial Report:
HARDLY A SCRATCH IN TV'S IMAGE
Broadcasting. November 2, 1959 (USA)

IN a lengthy report on the television 'quiz' scandal, *Broadcasting* describes the survey and analysis methods used by the Philadelphia market research firm of Sindlinger and Company to gauge the American public's reaction. A sample of 2,289 people was interviewed, throughout all parts of the United States. Answers to questions were recorded verbatim and analysed after the completion of the survey. This coding of answers is done manually.

'The system defies electronic tabulation. Mr Sindlinger has called in all the major business machine companies for consultation . . . and they've all declared it impossible . . . to achieve the speed required . . . It would take weeks to determine by machine the results hand tabulation achieves in hours.

'After that step, however, automatic calculators are brought into play. Counting machines render totals in each category after the cards have been hand-graded and sorted. Then calculators (IBM 632 Electronic Typing Calculator) apply known data to the sample data to reach, automatically and error-free, the figures which go into the final Sindlinger report.'

IBM PROCESSING CENTRE INCREASES FACILITIES

INCREASED facilities for the IBM 650 computer have been provided at the IBM Data Processing Centre in Wigmore Street by the addition of an IBM 653 with indexing register and floating point arithmetic. On certain applications, particularly those of matrix manipulation type, the increase in speed can be up to three times that when using the basic machine.

GHENT UNIVERSITY INSTALLS A COMPUTER

THE Faculty of Science at the University of Ghent has installed an IBM 610 automatic decimal point computer for use in scientific and engineering work, particularly for solving problems connected with nuclear physics, astronomy and astrophysics.

Work already scheduled includes the calculation of spatial and angular distributions of neutrons and electrons, the calculation of energy distribution and of actual temperatures of neutrons, the treatment of dynamic problems connected with the Milky Way, and for flutter and vibration analysis.

AMERICAN BANK TO HAVE TOTAL ELECTRONIC SYSTEM

THE Fifth Third Union Trust Company of Cincinnati, Ohio, USA, will become the first bank to install the new National Cash 304 electronic bank automation system. The system is scheduled to be in operation by January 1961. The bank will thus become one of the first of the 15,000 banks in the United States to install a magnetic character system.

The new system will handle all checking-account records for the bank's 70,000 accounts and will keep all personal loan records and personal trust records.

G Carlton Hill, the bank's president, said that the installation would drastically reduce the bank's paperwork, speed the preparation of essential reports and result in other efficiencies.

At present the bank processes up to 120,000 of its own cheques and deposits daily and 150,000 items for other banks. This volume of paper work will probably be doubled within the next decade.

The heart of the National Cash system, which was designed to combine sound accounting methods with electronic efficiency, is the National 304 electronic computer with its 10 peripheral units. The central data processor has transistors and printed circuits of latest design. The peripheral units include magnetic tape files, a high-speed printer and two Pitney-Bowes cheque sorters.

The installation of the system comes after several years' planning.

MECHANISED RATE COLLECTION

SHEFFIELD Corporation is using an ICT 542 electronic multiplier in the City Treasurer's office for the collection of rates. In his survey of the last financial year the City Treasurer of Sheffield reported: 'The benefits which are now being reaped include the balancing of the whole of the rating and water accounts within a week, the receipt of the rate income much earlier than before and a substantial saving in loan interest charges. The money comes in more rapidly and with less trouble: the staff foresee immeasurably better prospects and are happy to be working in a department which has saved the city £20,000 a year.'

NAAFI PAYROLL ON CALCULATOR

THE payroll for the weekly paid staff of NAAFI, who number 13,000, is now calculated on an ICT 555 which will soon be used also for monthly salaries of NAAFI officials.

20,000 HOURS

AN average of 99.09 percent of effective usage time has been recorded for an IBM 650 computer which has been in use at Rolls Royce Limited since January 1956. The calculation is based on 188 weeks of usage, up to August 15, 1959, with a weekly average of 109.6 hours' usage time and 1.003 hours down time.

FOR RESEARCH

THE Road Research Laboratory of the Department of Scientific and Industrial Research have ordered a Pegasus computer which will be used for all aspects of road research calculations—in particular, problems associated with road traffic and safety.

A second Pegasus has been ordered by The Steel Company of Wales. Intended primarily for research studies, the computer is likely to be installed in the company's Operational Research department at Port Talbot within the next few months.

These two orders bring the total number of Pegasus machines sold to 30.

COMPUTERS FOR SMALLER FIRMS

THE Central London Productivity Association organised a conference under the title, 'Computers for the Smaller Firm,' in the conference hall of the Federation of British Industries, at 21 Tothill Street, Westminster, on Thursday, October 22. The conference was presided over by Mr H W Underhill, Chairman of the Central London Productivity Association, and the speakers were: Mr T R Thompson, Mr W A Freyenfeld, Mr C M Berners-Lee, Mr John A Goldsmith, Mr S A Grimes and Mr H H Simmons.

Mr. Thompson, who is a director of Leo Computers Ltd, emphasised several crucial points which possibly cannot be too often repeated. For example, the reorganisation and rationalisation of a company's procedures that are necessary before installing a computer may, he said, be found worth while, even if a computer is not installed.

The consultant or manufacturer who advises on an installation and undertakes to plan it should certainly be bound to guarantee its effective operation; and an installation should not be recommended on the basis of 'intangible' advantages: if it is a good installation, it is an economic one that will save time, wages, salaries or capital costs.

There is an obvious value in service bureaux for smaller firms. Mr Thompson envisaged the growth of such bureaux operated by municipalities, firms of accountants and, possibly, by banks.

Mr Freyenfeld, in outlining the characteristics and capabilities of computers, attempted gallantly but, perhaps, vainly to scotch the persistent idea that electronic machines can 'think.' He rather weakened the argument by describing them as 'moronic.'

On safer ground, he made an interesting estimate of the potential computer market in Britain as between £300 million and £500 million. He quoted some case histories, illustrating the various uses of computers of smaller capacity.

Both Mr Berners-Lee and Mr Goldsmith recommended computer service centres for beginners. Mr Grimes gave an account of integrated data processing, and Mr Simmons reported on a year's experience of stores control in the GPO Supplies branch.*

* See 'Effective Stores Control in the Post Office,' *Automatic Data Processing*, August/September 1959.

New Computers: Business and Scientific

1 IBM's 1401 Data Processing System

THE latest in the IBM range of transistorised data processing equipment is the IBM 1401, which should answer the needs of smaller businesses for whom good processing speeds are important. Its features include card reading at 800 cards a minute, card punching at 250 cards a minute and printing at 600 lines a minute.

With fast input and output, the IBM 1401 combines the stored program versatility and the logical power of larger computers.

The basic system consists of three units that fit compactly into an area of about 300 square feet. Six magnetic tape units can be added to the system, each giving a transfer rate of up to 62,500 characters a second.

A unique feature of the 1401 system is the new method of printing. This uses a precision-made chain of engraved type faces, operated by electronically timed hammers which allow it to maintain its high printing speed without loss of alignment or quality. A skip over unused sections of forms, operating at 75 inches per second, gives an output performance equivalent to that of a conventional printer working at 4,800 lines a minute.

The magnetic core storage has 1,400 or 2,000 or 4,000 alphanumeric positions. One position holds one digit, one alphabetic character or one special character. The basic character cycle rate is 12 microseconds per character.

Every character is individually addressable and the variable word length allows the most versatile use of storage capacity. Output formats are under complete control of the program, by means of one instruction and a control word.

The logical and arithmetical circuits are completely transistorised. Examples of calculating speeds are: Add two 8-digit fields in 0.31 milliseconds; multiply 6-digit field by 4-digit field in 15 milliseconds without the direct multiply-divide feature, or 2.4 milliseconds with the feature; compare two 6-digit fields in 0.24 milliseconds.

CARD READ PUNCH

The IBM 1402 card read-punch has a file feed capacity of 3,000 cards and a maximum reading speed of 800 cards a minute, limited by the speed of output operations. The punching speed is 250 cards a minute. There are five radial stackers from which cards can be removed without stopping the machine. Cards are separated under control of the program so that exception cards, for example, can be separated at the time that the exceptional condition is discovered.

PRINTER

The 1403 printer operates at 600 lines a minute from tape or storage, and at 400 lines a minute listing. It prints 10 characters to the inch, giving 100 or 132 characters per line.

The high-speed skipping device operates at 33 inches per second for the first eight lines and at 75 inches per second thereafter. There are 48 characters in every print position: 10 digits, 26 letters and 12 special characters.

PRICE

The price of the basic system, not including the direct multiply-divide feature or the extra-high-speed skipping device (at 75 inches per second) is less than £50,000.

2 The Ferranti Orion System

FERRANTI have begun production work on the new Orion high-speed data processing system, which they claim to be one of the fastest and most powerful of its type in the world.

Some of the outstanding features of Orion are the automatic time sharing and priority processing, enabling the machine to work at its maximum capacity on two or more programmes simultaneously, its extensive magnetic core storage, its built-in facilities for commercial arithmetic and the automatic safeguards which ensure that programs in the computer cannot interfere with each other.

The Orion system uses the Neuron logical elements which have been proved in the Sirius computer. These elements enable complex systems to be built with a minimum of components and with maximum reliability. The computer is fully transistorised.

THE STORE

The magnetic core working store has a capacity of between 1,024 and 16,384 words, depending on requirements. It is backed by a number of magnetic drum units which are treated as peripheral devices.

A drum unit normally has a pair of drums each with a capacity of 16,384 words, with a mean access time of 12 milliseconds.

A word in the store may be regarded as equivalent to a 14-decimal digit number represented by 48 binary digits, eight alphanumeric characters of six binary digits each, or one three-address instruction or one modified two-address instruction.

PERIPHERAL DEVICES

The following peripheral devices are being incorporated in the first Orion system: a two-drum unit, card reader, card punch, line printer, four Ampex FR 300 magnetic tape units, a Rank Xeronic printer, a Flexowriter typewriter, fast and medium speed Ferranti photo-electric paper tape readers (TR7 at 1,000 characters per second and TR5 at 300 characters per second), fast and medium speed Creed perforating punches (33 and 300 characters per second), and a Teletype punch at 60 characters per second.

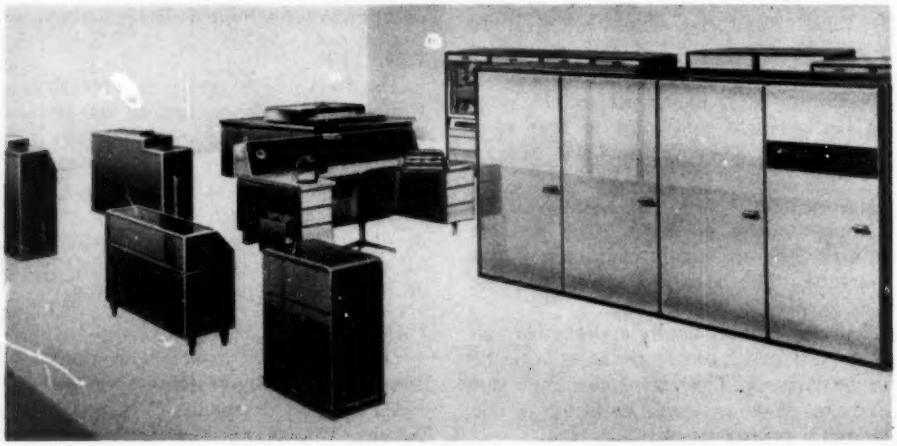
TIME-SHARING

The time-sharing system of the Ferranti Orion ensures that the computer is always doing useful work while peripheral transfers take place and at the same time that peripheral devices are always kept working to capacity.

When a peripheral transfer is finished, and when the computer attempts to refer to data involved in an incomplete transfer or to any equipment involved in such a transfer, then the time-sharing system processes the program priorities in the machine store and decides whether to continue the operation of the present program or to switch to another.

In general, the computer will switch to the program of first priority which is not waiting for the completion of a peripheral transfer.

'Time-sharing' and 'priority processing' are two important features of Ferranti's Orion system, which will be in full production by the end of 1961. Its price will fall between £100,000 and £300,000 depending on the size and scope of system required



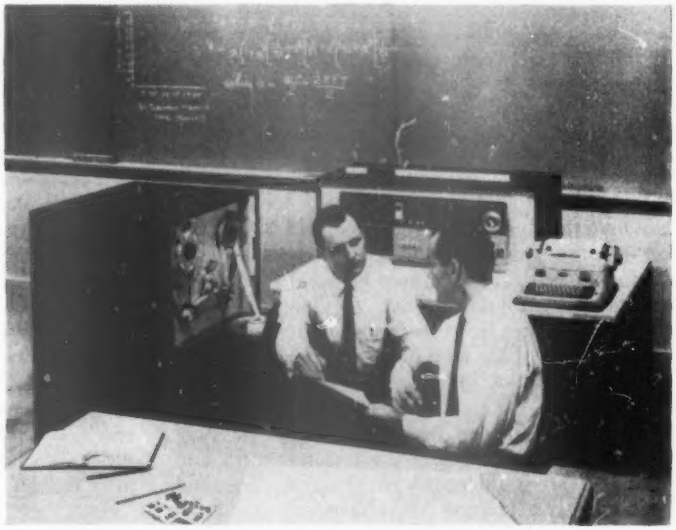
ORDER CODE

The order code of the computer has been devised to facilitate the use of the latest commercial automatic coding methods. The time-sharing arrangements mean that it is no longer necessary for the programmer to devote a lot of his time to ensuring that as much use as possible is made of transfer times.

SPEEDS

The system is very fast, partly because the orders are obeyed very rapidly, partly because orders are carefully chosen and partly because of the high speed of the magnetic tape system. Multiplication takes from 64 to 200 microseconds; the conversion of an eight-character field into binary takes up to 400 microseconds.

3 A New Scientific Computer by IBM



Priced at £29,270, this scientific machine may also be rented at some £600 a month. Delivery will take 14 months to effect

A SMALL, powerful stored-program computer designed for complex scientific and engineering work was announced last month by IBM United Kingdom Ltd. This is the IBM 1620, capable of performing over 100,000 calculations a minute.

The system consists of a central processing unit, a paper tape reader and punch, and it occupies little more space than an ordinary office desk.

Programming of this transistorised machine is simplified by the availability of two advanced program systems and a comprehensive library of mathematical and statistical routines. Specific programs are available for the petroleum industry, public utilities, civil engineering firms and optical firms.

TECHNICAL SPECIFICATIONS

Additions and subtractions of five-digit factors are performed at 1,780 calculation per second; multiplications of five-digit factors at 200 per second; comparisons of five-digit factors at 1,780 to 5,000 per second. Data transmission of two-digit fields operates at 4,160 per second.

The system has odd bit parity validity check on input, internal data transmission and output, validity check on addresses, and overflow check on addition, subtraction and comparison.

THE CENTRAL PROCESSING UNIT

Internal data representation is self-checking, six-bit, binary coded decimal. The core storage has a capacity of 20,000 digit positions, of which 300 are permanently assigned for use in arithmetic operations. Each digit position is individually addressable by a five-digit address.

The arithmetic and logic unit has a two-address instruction format of 12 digits, fixed length. Addition, subtraction and multiplication are accomplished by an automatic table look-up method in the core storage. Division is operated by an available subroutine.

The console displays machine check indicators, program registers and storage locations and incorporates a typewriter keyboard.

Input is by the IBM 1621 paper tape reader, at a rate of 150 characters per second. The IBM 961 tape punch has an output rate of 15 characters per second. Eight-channel paper tape is used.

The symbolic programming system provides for the use of symbolic operation codes and addresses in the preparation of programs. The FORTRAN system can also be employed.

BOOK REVIEW

The State We're In

by ERROLL WILMOT

F H George: Automation, Cybernetics and Society. Leonard Hill (Books) Ltd. London. 35s.

SOME attempt to think clearly about the social consequences of automation is obviously imperative. The point scarcely needs to be laboured that blind pursuit of technical inventions, without thought of their effects on the daily lives of human beings, is not only abysmally unintelligent but positively dangerous. Dr George deserves credit, therefore, for trying to set down in this book his idea of the kind of society that is likely to evolve under the influerce of automation and cybernetics.

'The point of view adopted,' he says on page one, 'is essentially that of the social scientist and logician who is interested in humanity first and last, and who believes that humanity stands to gain new worlds by proper use of scientific advances but is equally close to the possibility of hell-on-earth. We have the opportunity to choose, to some extent, what sort of world we shall have. This choice is becoming crucially important for our very survival, and a knowledge of the facts is the prerequisite for any sensible choice.'

The prophetic, rhetorical note in this quotation adumbrates one of the weaknesses of Dr George's attempt to come to grips with his undeniably important subject. The same note is sounded repeatedly through the book and it must be admitted that it is apt to become, in the absence of 'the facts', merely irritating. One of the difficulties, of which Dr George must have been made aware in the course of writing the book, is to determine which facts are relevant to the sort of book he was trying to write.

LACK OF METHOD

There is an appearance of method in the arrangement of the contents. A prefatory 'argument' is followed by 21 chapters arranged in three parts, headed respectively 'The Social Background of Automation,' 'Cybernetics and Automation,' and 'Operational Research and Automation.' This appearance is, however, deceptive. For example, the chapter on 'The Future of Civilization' (Chapter XXI) is bundled into Part Three, following immediately after 'The Automatic Factory'; and 'Cybernetics and Psychology,' in Part Two, follows immediately after two semi-technical descriptive chapters, 'Computers and Computations' and 'Servo-Systems,' though there is no logical justification for this sequence.

The reason for the lack of genuine order is, I think, a quite simple one: Dr George has attempted to deal with too many aspects of an extensive area of human knowledge, and he has dealt with them on various levels. In plain, colloquial language, he has bitten off more than he could chew, and the result is that the reader is invited to share his indigestion and, incidentally, the nightmares that arise from it.

VISION OF HORROR

For the vision of the world of, say, 1984 that Dr George presents is beyond dispute one of unrelieved horror, in spite of the humanist and humanitarian protestations with which he presents it. It is a world of supine boredom in which art and religion have been reduced to the level of 'hobbies' in a desperate attempt to overcome the futility of existence by universal occupational therapy.

The reason for this philosophy of despair is perhaps explained by the nature of Dr George's academic training and interests. He is a lecturer in the Department of Psychology at Bristol University and his principal studies seem to have been in mathematical logic at Cambridge and at Princeton. He has also made a study of the techniques of 'brain-washing' and he professes an interest in cybernetics as the synthesis of all the scientific disciplines. It is no surprise to find that his interpretations of psychology are consistently behaviourist: consequently, the distinction between human and machine is in his view a narrow one. This is particularly unfortunate in a man who combines the training of a mathematician with a good deal of the temperament of the politician. The combination bears fruit in a proliferation of rhetorical platitudes and large-scale abstractions

which pay too little attention to factual detail.

AUTHOR'S MAIN PURPOSE

It is difficult to know where to begin in reviewing a book that darts about among so many different subjects; but it seems fairest to try to assess it in terms of what seems to be the author's main purpose. I take this to be to present a conspectus of contemporary society and society in the immediate future, considered in relation to the techniques of automation and cybernetics. In other words, it is meant to be primarily a sociological essay. In such a context, it seems to me, a detailed description of a computer system or a technical description of servo-mechanisms is out of place. Dr George includes both, and yet he manages to give too much detail for the social study and too little for the reader in search of technical information.

HARE RAISING

It will perhaps be possible by selected quotation to indicate the number and variety of hares that Dr George starts up and some of the hair-raising shapes they take.

In Chapter I, ' Science and Common Sense,' he says: ' We are at the beginning of the biggest social revolution that the world has yet seen, far greater in size and implication than the industrial revolution, and this time we cannot afford to be ignorant of the facts.' (Note the rhetorical gesture towards ' the facts.') Again, in the same chapter: ' Let us put the point quite generally. We are building, or we are about to build, machines that will change the face of our civilisation, and *unless we are ready to change ourselves* at the same time, and see the reasons for the changes, we may be without a future in which to change at all.' (My italics.)

On the same page: ' It is quite clear that there has been in the past a steady tendency to evolve from the unplanned to the planned society.' Like others of Dr George's rhetorical generalisations, this does not stand up to scrutiny. If the statement means anything—and this is by no means to be taken for granted—it is at variance with a great deal of anthropological and historical knowledge.

REAL PROBLEMS

In a book of this kind, the lack of historical sense is a serious defect. Dr George's training as a mathematician and a psychologist does not, in fact, fit him for the role of sociologist. This is perhaps the fundamental fault in a book which, despite its many defects, does make some attempt to come to grips with real problems.

A semantic hare is started up on page 22, rather naïvely introduced, and almost immediately abandoned for a mathematical hare: ' The first thing of importance is to realise that mathematics is simply a language.' There is a world of significance in that ' simply.'

Five pages later, a sociological hare: ' One of the big problems of the future is that of the development of greater and greater specialisation in social groups.'

OBSESSED

Dr George is obsessed by the idea of machines as substitutes for human beings, not merely in the ordinary industrial processes of modern society, but as alternatives to living organisms: ' There is no reason, in principle, why we should not ourselves construct human beings,' he says on page 46, begging the semantic question with something approaching *panache*.

The semantic hare reappears in Chapter VI, on ' Signs, Language and Communication,' where it is introduced rather apologetically: ' These problems of language may seem academic and remote . . .' It seems a curious attitude to adopt to a subject so manifestly of direct and immediate importance. But again Dr George's mathematical training is revealed as inadequate to the task he has set himself. He does not understand linguistic problems, as is clear from the following paragraph (page 71):

' What many semanticists, and mathematical logicians, have tried to do is to construct precise languages for various definite purposes of analysis and description. It is widely recognized that natural language suffers from vagueness and ambiguities which are actually useful in ordinary conversation, but make it unsuitable for the conveying of precise ideas. Thus the argument goes: we should develop languages that have words with precise meanings and precise laws of grammar. English, for example, has neither of these. It has only approximate laws of grammar and approximate meanings, and one word can be used to convey many different ideas. For example, the word " love " could be used to describe a man's attitude towards his job, his mother, or his wife, and the meaning would have different implications according to which was the object of his affections. The meaning attributed to the word " love " thus depends partly on the context in which it is used.'

NONSENSICAL

Almost every statement in the foregoing quotation is nonsensical. One cannot ' construct ' a precise language. One can, in certain contexts, use agreed terms precisely. There is no such thing as a ' natural language.' Sanscrit, English and Algebra are all artificial languages, as all language depends on a conventional acceptance of mutually agreed signs. Words cannot of themselves have ' precise meanings.' The meaning a word has is what its user and its hearer understand by it. There is apparent precision in mathematics because

mathematical statements are tautologies, comparable to the verbal statement: ' This table is a table.' (Readers unacquainted with semantic questions must take this statement for granted, as there is no space for full discussion of it.)

This apparent digression from the subject of automation is in fact strictly relevant to discussion of Dr George's book. Much of it is meaningless because fundamental linguistic factors have been overlooked. Thus, in his chapter on ' The Philosophical Problem of the Machine,' Dr George is able to say that the question ' Can machines be made to think?' does have ' some practical importance, since there still exists a large body of opinion which regards machines as in some ways fundamentally different from organisms. Such a prejudice . . . is bound to have an unprogressive effect on certain aspects of modern science,' without realising that he is not discussing machines and organisms but the referent of the word ' think.'

MECHANISTIC PSYCHOLOGY

The same inability to appreciate the nature of a semantic problem vitiates the whole of the following chapter, on ' Organisms, Models and Feedback.' Consequently his arguments for the acceptance of a mechanistic psychology fail to convince. Needless to say, I am as prejudiced in favour of a ' vitalist ' view of psychology as Dr George is prejudiced in favour of a mechanistic view. Neither view has much meaning, however, without very careful definition of terms.

There is some evidence of carelessness and haste in the compilation of the book. On page 180, for example, the lettering in the text does not correspond with the lettering in the diagram to which it refers. There are examples of syntactical carelessness: ' Similarly, a machine, working on a basis of random numbers, might be made to produce poetry of a form indistinguishable from many a modern poet . . .' (page 213) and ' The design of man-operated equipment must be designed so as to avoid work under damaging conditions.' On page 209 we are told that ' physical anthropology is concerned with the environment of man . . .' and that ' anthropology is concerned with the study of primitive peoples.' Both statements parody the truth.

FREEDOM

Notwithstanding all the strictures that have been passed here upon Dr George's book, there are good reasons why it deserves to be read. There are still a great many people who are apparently unaware of the existence of some of the social and moral problems that are posed by automation, and to which Dr George draws attention. He is, I think, right when he says: ' It remains my belief that the greatest struggle for people in the future society will be to preserve the freedom of the individual, which is likely to be far more threatened than ever before.' Where he appears to me to be wrong is in supposing that this ' freedom of the individual ' can be threatened by technical invention rather than by man himself. The freedom of the individual succumbed in ancient Egypt and was reasserted in Periclean Athens. It succumbed again in the ' dark ages ' of Europe and was reasserted in Renaissance Florence. It has succumbed again in the managerial states of the twentieth century and will no doubt be reasserted in the next golden age. A knowledge of human history would have given Dr George this kind of perspective, which his book lacks.

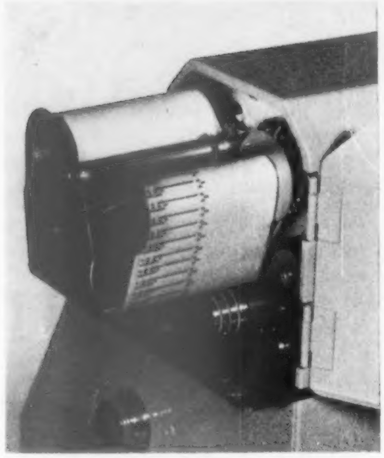
The whole problem is put succinctly by Hannah Arendt, in her book, *The Human Condition*, in terms which contrast markedly with the rhetorical flights of Dr George:

' It is in the structure of the human brain,' says Dr Arendt, ' to admit that two and two equal four. If it were true that man is an *animal rationale* in the sense in which the modern age understood the term, namely, an animal species which differs from other animals in that it is endowed with superior brain power, then the newly invented electronic machines, which, sometimes to the dismay and sometimes to the confusion of their inventors, are so spectacularly more "intelligent" than human beings, would indeed be *homunculi*. As it is, they are, like all machines, mere substitutes and artificial improvers of human labor power, following the time-honored device of all divisions of labour to break down every operation into its simplest constituent motions, substituting, for instance, repeated addition for multiplication. The superior power of the machine is manifest in its speed, which is far greater than that of human brain power; because of this superior speed, the machine can dispense with multiplication, which is the pre-electronic technical device to speed up addition. All that the giant computers prove is that the modern age was wrong to believe with Hobbes that rationality, in the sense of " reckoning with consequences," is the highest and most human of man's capacities, and that the life and labour philosophers, Marx or Bergson or Nietzsche, were right to see in this type of intelligence, which they mistook for reason, a mere function of the life process itself, or, as Hume put it, a mere " slave of the passions." Obviously, this brain power and the compelling logical processes it generates are not capable of erecting a world, are as worldless as the compulsory processes of life, labor and consumption.' *

* *Hannah Arendt: The Human Condition. The University of Chicago Press. 1958. Pages 171, 172.*

An advance in

Cash Sales Automation



The audit strip and mechanism in the Sweda cash register. The strip is printed in the bar code and in arabic numerals, the corresponding figures appearing side by side.

THE Leeds Industrial Co-operative Society Ltd has contracted to hire the first installation of the new Sweda E-3 electronic reader, which was shown in prototype at the Computer Exhibition at Olympia in November 1958 and which is now in commercial production. The forthcoming installation—to be made in 1961—was announced during November by London Office Machines Ltd.

In the Leeds installation the Sweda E-3 will be connected to a magnetic tape sorter, a control unit and a printer. The assembly will be used for the computation of members' dividends, based on cash purchases.

When a cash sale is made, the member's share number is entered on the Sweda cash register keyboard, with the price of each item bought. The member is given an itemised ticket, recording the purchases and the member's share number. At the same time, the audit strip in the cash register records the share number and the cash total in the Sweda bar code.

The complexity of the problem of electronic reading of Arabic numerals led Sweda research workers to develop a basically simple system in which the figures from 0 to 11 are represented by four bars having the values 1, 2, 4 and 8 in binary code. Each figure has two additional bars, one of which is a ' start ' signal which synchronises the reading, and the other is a ' check ' signal. The start signal is always positive. One considerable advantage of this system is that it is easy for human operators to learn and read it.

The audit strip, and its very accurate printing mechanism, can be fitted to any Sweda cash register.

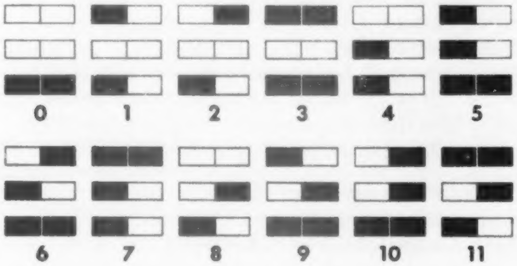
Any length of the audit strip can be removed from the cash register and put through the reader as necessary. The audit strip is placed in position in the ' handler ' of the E-3 and, when the machine is started, it runs past an illuminated slot in front of a lens which projects the characters on to sets of photocells corresponding to the character positions.

When the character image passes over the photocell sets and the lower left (start) bar, which is always black, begins to cover the start photocell it gives a ' read ' pulse which causes the condition of the other five bars to be recorded in a memory circuit. From here, following a parity check, the information is forwarded to the output.

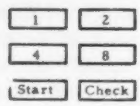
If the parity check detects an error the machine stops and an image of the faulty line appears on a screen behind a viewing window. A red light identifies the faulty character and at the same time the appropriate group of six push-button switches is illuminated. The machine operator can then correct the error by reading the image through the viewing window and pressing the appropriate switches.

For increased accuracy a summation check is also used. When the audit strip is to be removed from the cash register for processing, the cash register is reset and the resetting totals are printed on the strip. When the strip is read by the E-3 these totals are checked against amounts of purchases recorded against each member number. If these tally, the chance of any reading error having occurred is negligible.

The Sweda E-3 is fully transistorised and has printed circuits. It reads at a speed of 1,000 characters a second, consumes 350 watts, connected to 220-volt AC mains supply, and weighs 225 pounds.



The Sweda bar code used on the Sweda cash register in conjunction with the E-3 reader. One great advantage is the ease with which operators can learn to read it.



Described by J M M PINKERTON
Director, Leo Computers Ltd

Features of the Leo IIC Computer

A COMPUTER for use on business applications needs special characteristics in addition to those possessed by machines built for mathematical and scientific purposes. This article will discuss these characteristics and show how they are provided in the LEO IIC computer, with magnetic core storage.

There are now few physical activities in any business undertaking that are not paralleled by a corresponding set of accounts. By no means all of these are kept in monetary units; hours of work, units of stock, numbers of machine tools and of staff all figure in the accounts. It is not surprising therefore that accounting procedures, especially in large- and medium-sized firms, are complicated.

Planning a business programme for a computer has become a specialised occupation and the programme itself has usually a more elaborate structure than one written for a scientific application. Moreover, both data and results are more copious, of more different kinds, but involve fewer individual arithmetical operations per unit than in mathematical work. Because there are more data it is also more difficult to make certain that every figure entered is correct. Offices staffed by clerks have always coped with these situations; so must the computer if it is to undertake any part of their work. It is not within the scope of this article to show how these problems are overcome, but rather to show how the design of the equipment is affected by them.

THE CLERICAL PROGRAMME

The raw data to be worked on are generally obtained from several different sources and are of various different categories which it is not convenient to blend together. We can have, for example, in a stock control job, closing balances from the last run, new issues, receipts for stock, details of orders placed for new stock, delivery promises and forecasts, consumption forecasts, orders for delivery of items to customers, price and purchase tax changes and so on. In general it is found that these types of data fall under about three broad heads:

1. New or original data, possibly of several kinds.
2. A brought forward data file arising from a previous run of the same job.
3. Fixed or semi-fixed data such as price lists.

It has been found that at least three different input channels are needed to feed these different

A general view of a Leo II installation. The cabinet between the two tape transports houses electronic circuits linking magnetic tapes with the computer. By means of switches on the panel of this cabinet the identity of up to eight tape decks can be interchanged at will. (Photo by courtesy of Decca Radar Ltd)

classes of data to the computer as they are needed by the programme.

Likewise results are of three main classes, viz:

1. Main printed results in large volumes, eg invoices, payslips, advice notes, statements, etc.
2. A carry forward results file.
3. Subsidiary results in small volume, but often of several different types, eg statistical or departmental totals, cost account details, etc.

Again at least two output channels are required, sometimes three or four.

Clerical programmes are gradually increasing in scope and power and therefore require more storage. Two thousand instruction words of high-speed storage may be insufficient and up to 8,000 or even 16,000 instructions may be required. For preference, all of the programme should be in a single high-speed store. Although it is possible to place sections of the programme on drums or even tape and bring them in as required, it is easier to manage the job if all sections are together in high-speed storage.

If the computer works in the binary scale it is imperative to have efficient means for converting numbers to and from decimal or sterling notation, and preferably for generating the printed result layouts as part of the binary-decimal/sterling reconversion process. A full range of other arithmetic instructions including division is required, with facilities for address modification (indexing).

Automatic checks on transfers within the machine and also on input and output are desirable, wherever they can be introduced without so much complexity that there is a significant risk of the check circuits themselves going wrong.

In order to ascertain what the computer is doing whilst in operation, experience shows that it is most valuable to have complete monitoring facilities. Ideally, every register and every storage location in both main and auxiliary store should be capable of inspection as the calculation proceeds. These facilities greatly assist engineers in maintenance and programmers in checking the coding of their programmes, as well as the operators in normal running.

MAIN FEATURES OF THE SPECIFICATION

LEO IIC is a versatile computing system offering the full range of input/output devices, including magnetic tape, a large core store using transistorised circuits, an efficient computing unit and a most comprehensive system of monitoring and supervisory controls. Its design was evolved by Leo Computers Ltd after many years of experience with LEO I. Unlike that machine (some of whose circuits were derived from those of EDSAC I), LEO II is built to the original design of Leo Computers' own engineers. The equipment is carefully engineered to stand a long period of intensive use and to be readily maintainable.

Arithmetic Unit

LEO IIC is a binary machine operating on either long or short words at will. Long words have 39 digits (38+1 sign bit), and short words 19 (18+1 sign bit). An instruction consists of a short word of 19 bits.

There is provision for 16 registers of 39 bits, of which 14 are normally fitted. There is direct access between the main store and certain registers, including the accumulator; in addition, transfers can be made directly from any register to any other. The two halves of the accumulator can be used separately if desired. The allocation of registers is:

Register 0	*Shifting Control*
Registers 1 to 3	*Modification (Indexing)*
Registers 4 to 7	*Direct access to and from store*
Registers 8 & 9	*Form Main Accumulator*
Register 10	*Subsidiary Accumulator*
Register 11	*Hold or Multiplicand*
Register 12	*Multiplier*
Register 13	*Results*
Registers 14 & 15	*Spare*

The actions carried out by the arithmetic unit are shown in Table I. Care is taken in the logical design to avoid wasting time on redundant steps, eg there are two adders in the accumulator loop and numbers can be added in on every minor cycle. This avoids any chance of delay with any action adding into the accumulator. Moreover, multiplication stops as soon as all significant digits of the multiplier are dealt with in the case of both positive and negative multipliers.

Conversion and reconversion of a number between binary and decimal or sterling is accomplished in the same time as multiplication by special instructions. In the case of reconversion for output, programmed format control is also included, the result being set out for printing, each number having the appropriate number of places including blanks. Suppression of unwanted zeroes also takes place automatically.

Main Store

The store is based on a core matrix of 64 x 64 wires, and has a capacity of 8,192 short or 4,096 long words, or any combination of short and long words. Smaller sizes of store can be had if required. Additional blocks of storage for 4,096 long words can be added if necessary. The store access time is 16 microseconds, but because of the need to transform numbers into the parallel form the effective time is one minor cycle (just under 80 microseconds). However, the waiting normally associated with serial type stores is eliminated and

TABLE 1

Schedule of the different input/output media and devices available with LEO IIC

In/Out	Medium	Reader/ Recorder	Code	Average Reading or Recording Speed characters/second	Blocks/ minute	Numeric characters or digits/word	Maker
In	5-hole punched tape	Photoelectric	Numeric	200	depends on word size	Variable 0 to 9	Ferranti
In	80-column punched card	Electronumber Card Reader	Alpha-numeric or binary	270	200	Alpha-numeric Variable 0 to 9- Binary,39 fixed	ICT
In or Out	Half-inch Magnetic Tape	High Speed Tape Transport	Alpha-numeric or binary	3500 Writing automatically checked	1320	Alpha-numeric 9 fixed— Binary, 39	Decca
Out	80-column punched card	Card Punch	Alpha-numeric or binary	135	100	Alpha-numeric Variable 0-15* Binary,39 fixed	ICT
Out	Printed result (standard speed)	80-column Printer	Numeric only	130	100	Variable 0-15*	ICT
Out	Printed result (medium fast)	140-column Printer	Alpha-numeric	460	300	Variable 0-15*	ICT
Out	Printed result (high speed)	120-column Printer	Alpha-numeric	1300	850	Variable 0-15*	Anelex Corporation

*including up to six blank characters

this makes LEO IIC faster by some 35 percent than earlier models of LEO II. A parity digit is introduced with all information stored which is automatically verified on its retrieval. An error causes the machine to stop.

The circuits associated with the store, ie the read/write selection switches, the read out amplifier and the serial/parallel conversion circuits are fully transistorised.

Auxiliary Store

As auxiliary storage there is available a magnetic drum storage system based on the Ferranti Model 1009 Magnetic Drum. Each drum has 128 tracks and a capacity of 8,192 long words, ie double the capacity of the main store. Up to four drums may be connected. All transfers to and from the drums are via buffers containing a block of 16 long words, and separate buffers are provided for reading and writing. The effective rate of transfer is 70 blocks per second. Reading and writing cannot occur at the same moment, but may occur as successive quadrants of the drum pass under the heads, if required. A parity check digit is automatically formed and written on the drum with every block. This digit is checked on reading back.

Input/Output Systems

Data can be read from five-hole punched tape, 80-column cards, or half-inch magnetic tape. Results can be recorded on 80-column cards, magnetic tape or printed on paper using one or other of a variety of line-at-a-time printers.

All input/output operations occur concurrently with computation, as every one of the mechanisms used feeds the computer via its own separate buffer store. This important facility was first introduced on LEO I, and enables LEO IIC to deal efficiently with several data and result channels at the same time.

The method of operation of an output buffer is straightforward. As a card, for example, is being read, information is gradually built up in the buffer corresponding to the punched holes. With a card reader operating at 200 cards per minute it takes roughly 300 milliseconds to read one card. When the buffer is full it is declared available to the computer and can be unloaded and its contents transferred to the main store in two milliseconds. Thus 298 milliseconds are available for calculating, or information transfers over other channels. The same principle is used in output buffers and also those linking magnetic tape transports or drums.

It is normally not difficult to organise the flow of data and results so that computation is not kept waiting on any of the input or output channels. The performance of LEO IIC on various types of input and output channels is shown in Table I. The card punch output channel incorporates a row parity check on every card punched. This prevents cards for carry forward being accepted as correct which are in fact incorrect.

Magnetic Tape Channels

The magnetic tape channels have been designed to operate with a Decca tape transport model 3000. This machine will drive the tape at 100 inches per second in either direction, with a starting and stopping time of less than 10 m.secs. A deck records blocks of 160 characters at 10 kc/s. Allowirg for checking, the system operates at up to 22 blocks per second.

Up to eight decks can be connected to a channel and any may be used for reading or writing; *both reading and writing may occur simultaneously on different decks*. Two independent tape channels may be provided if required. All tapes are fully erased by a separate head before writing, thus inter-deck alignment errors cannot cause incomplete over-writing of previous information.

The emphasis in the design of the LEO IIC magnetic tape system has been on complete dependability. It was felt that the most important consideration was to be certain that every block written was correct at the time of writing. To discover a recording error when reading the block later causes great dislocation in the running of any job. Therefore an automatic and complete check from a separate head on every character written on the tape is performed immediately after writing each block. Whilst checking is in progress no further recording can take place since the block written is retained in the buffer for the purposes of the check. As a result approximately half the tape is left blank whilst running in the forward direction. At the end of the tape there is an automatic reversal and the blank spaces are then filled with blocks written in the opposite direction. With this arrangement there is minimum wastage of the tape and no rewinding is necessary if a tape is fully recorded. In the event of a check failing, the block is marked faulty and automatically re-written once, further down the tape.

Programme Facilities

LEO IIC uses a single address code, with an

TABLE II

Abbreviated Schedule of LEO IIC Actions

(a) Modifiable Actions

Note:— [ ] = Contents of
e.g. [N] = Contents of store location N

Code			*Effect*
1	ADD	[N]	to [8, 9]
3	SUBTRACT	[N]	from [8, 9]
5	TRANSFER	[8, 9]	to N and clear 8 & 9
7	COPY	[8, 9]	to N
9	REPLACE	[8, 9]	by [N]
11	AUGMENT	[N]	by [8, 9] and clear 8 & 9
13	MULTIPLY	[11]	by [N], add product to 8 & 9
15	MULTIPLY	[11]	by [N], subtract product from 8 & 9
17	ADD	[N]	to [10]
19	SUBTRACT	[N]	from [10]
21	TRANSFER	[10]	to N
23	SET UP	[N]	in 11, 11 being cleared beforehand
25	COLLATE	[N]	with [11] and add result to [8 & 9]
27	CONVERT	[N]	as long number from binary/decimal or binary/sterling into binary and ADD result to [8 & 9] Discriminant = 1 for binary/sterling
29	WRITE	[write buffer] onto auxiliary store block of address N, *or*	
	READ	[auxiliary store block address N] into read buffer.	Discriminant = 1 for READ
31	BULK COPY	[block N] to block N	This order is given in two parts to specify addresses N and N.

(b) Non-modifiable Actions

For these actions the nature of the operation itself may be varied by the modifier bits and/or the discriminant bit.

Code	*Effect*
0	This action has 6 variants, viz: STOP, PRESET STOP, SEQUENCE CHANGE if [8 & 9] = 0 otherwise STOP, SEQ. CHANGE if [10] = 0 otherwise STOP, UNCONDITIONAL SEQ. CHANGE, or PRESET SEQ. CHANGE
2	2 variants COUNT in mod. register m TEST [m] $\neq$ 0 and CHANGE SEQ. to N, *or* SET UP [N] in m
4	2 variants TEST [8 & 9] *or* TEST [10] m specifies test = 0, $\neq$ 0, > 0 or < 0
6	INTER REGISTER TRANSFERS adding or subtracting, clearing source or destination as specified by m. Both registers are specified by digits of N.
8	COPY [register 4, 5, 6 or 7] to N. m specifies register concerned.
10	ADD [N] to register 4, 5, 6 or 7, m specifies register concerned.
12	2 variants MULTIPLY [11] by [12] and ADD or SUBTRACT from [8 & 9] *or* ROUND OFF [8 & 9] to 39 bits.
14	2 variants SHIFT under control of register 0 to which N is first added. [0] negative indicates shift right, *or* SCALE NUMERATOR in 8 & 9 prior to division.
16	2 variants DIVIDE [8 & 9] by [11] result to 13 *or* EXTRACT SQUARE ROOT of [8 & 9] and place result in 13.
18	Unused
20	RECONVERT [8 & 9] to binary/decimal or binary/sterling to number of places indicated by digits 16-19 of N, sending result to 13. Process automatically interrupted to stack [13] when full.
22	2 variants OUTPUT block address N to channel, m *or* INPUT block from channel m, to address N.
24	2 variants FORM SUM TOTAL of block address N in register 10, *or* INSPECT information in input channel into N, but without clearing buffer in that channel.
26	2 variants CLEAR one block address N, *or* FILL one block, address N, with non-significant zero character.
28	Magnetic Tape Action—5 Variants SHUNT OUT and WRITE on deck specified, SHUNT OUT and WRITE with RESTART MARK, READ from deck specified one block into buffer, BACKSPACE one block on deck specified, *or* RUN BACK to restart mark on deck specified.
30	2 Variants SHUNT OUT specified block to specified buffer on drum channel, *or* SHUNT IN specified block to specified buffer on tape or drum channel.

instruction of 19 bits. The allocation of these bits is:

Digits 1 *and* 2	*m=Modification number*
Digit 3	*d=Discriminant Digit*
Digits 4-8	*A=Basic Action Code*
Digits 9-19	*N=Store Address or Register Addresses*

Actions in the basic code range 0-31 are divided into two groups, the odd numbered actions for which the address is modifiable, and the even numbered actions for which the action to be performed is varied, but the address is not modifiable. A list of the actions is given in Table II. From this it may be seen that the actions are well adapted to meet the requirements of clerical programmes outlined earlier. The conversion and reconversion facilities and the block input and output facilities have already been mentioned as have the bulk input and output transfers. Flexible facilities are also provided for transfers between any two registers in the arithmetic unit.

It must be emphasised that in order to present all the actions in the form of a table, many significant details and qualifications have had to be omitted.

For the modifiable actions:

m=0 if address is not to be modified
=1, 2 or 3 to modify it by contents of corresponding modifier register.
d=0 for short number operands
=1 for long number operands

For the non-modifiable actions *m* and *d* have differing significance according to the action in question. In some cases again the address digits have special significance, eg in the inter-register transfers they specify source and destination registers, and in the reconversion action certain digits of the address signify to how many places the reconverted result number should extend. The reconverted numbers always go to a certain block in the store.

The address digits specify the short number address in the store, thus the 11 digits available specify addresses from 0 to 2047. The higher numbered addresses in the store are accessible by block transfers as in the case of the auxiliary store; due to the parallel nature of the core store these transfers take place rapidly, a block of 16 long words being copied in 640 microseconds.

Programmes are written on paper with action numbers and address all in decimal form. In addition addresses in each stage of the programme are relative to the starting point of that stage. The first time a programme is required it is punched into paper tape as a series of decimal digits. A special Leo computer programme then converts the instructions to binary and stacks them away in the correct absolute address in store. To speed up feeding the programme subsequently it is then punched out into cards in binary form, with card serial numbers and check totals. Programme feeding from cards seldom takes more than 30 seconds.

Engineering Features

A vast amount of skill and experience has gone into the engineering design of LEO IIC. Although many technical features are not readily described for the non-specialist, some may appropriately be mentioned here.

The monitoring and control features of Leo are most comprehensive. All parts of the main and auxiliary stores, the input/output buffers and the computing registers can immediately be viewed on oscilloscopes.

Marginal testing of some 500-600 separate test points, individually, in groups, or all at once is controlled from a panel on the upper left hand side. On the upper right hand side is a panel allowing the engineer to insert orders or numbers into store, and check the state of all the trigger circuits from one point.

The circuits are mounted on readily removable units and all are easily accessible for maintenance *in situ* if needed. The rack structure of the computer is bolted up, hence the whole installation is dismantled in the factory, re-erected and checked out on site within 14 days.

The electronic circuits have extreme dependability built into their design, inasmuch as all components, valves and power supplies associated in one circuit must drift considerably outside their rated tolerances simultaneously in the least favourable direction before the circuit fails. In addition, long-life or special quality valves are used throughout. A typical installation may include 7,000 valves and 18,000 crystal diodes. It is most important to avoid accidental or consequential damage to crystal diodes. All Leo power supplies are carefully interlocked to prevent the failure of any one supply causing damage to crystals. Again protection circuits are included to prevent damage to crystals from the removal or failure of any thermionic valves.

Power supply is from an a.c. generator via 3-phase rectifier sets mounted in cubicles. To reduce noise the generator set is usually installed outside the computer room.

The ventilation system of LEO II is arranged to give a direct blast of cool air to the components which are so arranged as to give efficient heat exchange with the air blast directed along the length of the unit. Each unit has a separate jet of cold air blown down it. The total air flow is 6,000 cubic feet per minute, and results in a temperature rise round the components of 10°F or less. No air conditioning is needed for LEO II in the British Isles.

Data Collecting AFTER THE COUNTDOWN

An advisory group of NATO held its annual assembly recently and discussed developments in scientific data processing for aero- and astro-dynamics

by E PATTERSON

English Electric Aviation Ltd

THE ninth general assembly of AGARD, the NATO Advisory Group for Aeronautical Research and Development, was held in Aachen, Germany, from September 24 to 25, 1959.

The assembly itself occupied only two days, but it was preceded by meetings of specialist panels covering a variety of subjects in the field of aeronautics, including aeromedicine, flight test, satellite data handling, flight control data systems, wind tunnel data systems, and high speed high temperature gas flow.

A considerable proportion of the avionics panel meeting dealt with the acquisition and processing of data from space probes, earth satellites and wind tunnels. Another important aspect of data handling considered was the intensive work being undertaken towards the development of automatic air traffic control systems and the integration of air traffic control with national defence systems.

SATELLITE AND SPACE PROBE DATA SYSTEMS

The paper submitted by J Taber[1] discussed, with illustrations from the Pioneer I and Explorer IV systems, the general problems associated with the gathering of information in space and its

transmission back to Earth. The importance of pre-transmission data processing to reduce the load on the transmitting system and the final data processing system was indicated. Emphasis is placed on the necessity for selective filtering of the final information in order to obtain the most significant information from the vast amount available from one satellite or space probe shoot.

H E Carpenter and J J Madden[2] described the now familiar Minitrack system for tracking earth satellites. Their paper briefly described the interferometer concept, the recording methods and the preliminary data reduction accomplished at the individual tracking sites before the data are transmitted to the network control centre.

Space Track[3] is the project set up in November, 1957, to maintain a complete surveillance of all artificial bodies in space. The observation network is global information being fed to the control and computing centre in Bedford, Mass. The necessity is emphasised for working in real time if the system is to have any military value, that is, the observation and tracking of hostile satellites or space vehicles. A similar problem arises in the case of the meteorological satellites[4 5]. However, the development of differential techniques, whereby the changes only are processed, may reduce the problem to manageable proportions. The final aim of all over-all surveillance systems is either to maintain an up-to-the-minute catalogue of all space vehicles in orbit or the over-all world cloud distribution, monitoring and recording the variations of the elements.

One of the long-term benefits derived from the Moon probe shoots, apart from the scientific data gathered in space, is the opportunity to develop communication systems capable of transmitting data from distances beyond the Moon; the same tests have developed fundamental techniques for the accurate tracking of vehicles deep into space.

The limitation imposed by the narrow bandwidth available for data transmission has resulted in the evolution of new encoding techniques in order to transmit the maximum amount of data to the highest degree of accuracy.

Eimer and Stevans[6] discussed these problems with particular reference to the Pioneer III and IV firings.

AUTOMATIC AIR TRAFFIC CONTROL SYSTEMS

From 1948 to 1958 the number of airline passengers increased from 13.1 million to 48.1 million, and the number of flight plans filed with the New York Air Route Traffic Control Centre increased from less than 300 per day to around 1,000[7].

The world-wide increase of air traffic coupled with the steady increase of flight speeds and inter-airline competition is creating a serious problem in air traffic control. The present system of personal surveillance of the situation on the approaches to a large airport by a human controller is in danger of being saturated. The alternative to saturation is prolonged holding of aircraft in stacking areas, which is a very expensive business and not likely to be popular with airlines operating on a narrow margin of profit.

Furthermore, if a defence system is to be of any use to forestall surprise attack, account must be taken of all aircraft movements.

Design studies for semi-automatic or fully automatic systems are being carried out in many countries.

Since the problem is fundamentally one of developing a closed-loop control system, operating with optimum efficiency under a variety of types of demand, it is no new thing to the control engineer to learn that one of the major difficulties being experienced is the assessment of the problem. This emerged clearly during the lively discussion accompanying the presentation of the papers.

The majority of the papers assumed a system in which the controller would have presented to him a picture derived from flight plan data, radar plots and radio fixes. The best method of presenting this information to the controller is being sought and various solutions preferred.

R F Hansford and Decca Radio[8] introduced a new system whereby each aircraft entering an area is allocated one of many programmes held in the control computer store. This programme should coincide as closely as possible with the aircraft's proposed flight through the system. The aircraft may be asked to modify its flight to suit the programme. Under these conditions all future conflicts will be known from the moment of its entry into the system.

The problem of integration of air traffic control with automatic defence systems is undergoing study and experiment in the USA[9] under the beguiling names of CHARM (CAA High Altitude Remote Monitor) and SATIN (SAGE Air Traffic Integration). The former has been completed and the latter is due to start in 1960.

Both utilise the over-all radar surveillance data processing system called SAGE (Semi Automatic Ground Environment).

It is clear that some of these systems demand the utmost in reliability from the hardware, with a proviso that if failure occurs the information already acquired should not be lost.

Most of the data systems described depend for their functioning upon the transmission of data along land lines of some form or other. In particular cases it may be necessary to use special cables for security or wide bandwidth requirements. In many cases, however, it is much quicker and cheaper to utilise a telephone line. A P Clarke, of British Telecommunications Research, described a system capable of transmitting binary coded information at 750 bits per second over telephone circuits. The system has been tested over distances of 1,000 miles and errors of less than 1 bit in 100,000 are claimed.

WIND TUNNEL DATA HANDLING

The application of automatic techniques to wind tunnel tests has reduced data extraction and test analysis from weeks to days. Consequently the quantity of data evaluated has increased enormously. This, while it may have had harmful effects on the technique of experiment, has undoubtedly contributed to the rapid strides made by aeronautical engineering in the last 10 years. It is clear that the low speed wind tunnel data system has attained maturity.

Mr Airey[10] pointed out that whilst in the USA the cost of the data system is expected to be a considerable proportion of the tunnel, in UK the data system is still an ancillary service to be installed at the lowest possible cost.

This point was illustrated by the fact that two UK papers dealt with attempts to build cheap and somewhat unorthodox systems. The English Electric Company are attempting to cut the cost of recording digital data at high speed by utilising Digitape, a metallised film on plastic base.

If the system described by Patterson and Readshaw[11] is successful it may establish the pattern for future wind tunnel data handling systems in Britain.

GENERAL ASSESSMENT

While it must be borne in mind that the information submitted to the assembly is unclassified it is reasonable to expect that the problems and techniques of data handling outlined in the various papers are not a great deal less advanced than those with a purely military application.

It is obvious that present data acquisition systems can rapidly saturate the largest processing system, especially if it has to work in real time, and some form of pre-transmission processing is essential if only to remove unwanted information. At the moment it is standard practice to transmit the total number of cosmic ray counts in a given interval; instead of each count. An alternative method, as data becomes more plentiful, is to measure only the deviation from an expected total. The present dilemma will, it is hoped, lead to a re-assessment of experimental and instrumentation techniques. The day has passed when the instrumentation engineer could be content to provide masses of data, confident that somehow the unfortunate programmer and his machine would sort it out.

Notes

[1] Some aspects of data acquisition and handling in ABLE Space probes—J E Taber—Space Technology Labs.

[2] Minitrack—H E Carpenter and J J Madden NASA.

[3] Space Track—G R—Miczaika—Air Force Cambridge Research Centre.

[4] The NASA Meteorological Satellite Program—R Jastron, Chief of Theoretical Div. NASA.

[5] Data Handling for the Meteorological Satellite—W G Strond, R Hanel and R Stampfl, Goddard Space Research Centre, Naval Research Lab, Washington.

[6] Tracking and Data Handling for the Pioneer III and IV Firings. N Eimer, R Stevens, Jet Propulsion Lab. CIT Pasadena.

[7] Semi-automatic Data Processing for US Air Traffic Control, Donald S King, US Federal Aviation Agency.

[8] Planning and in-flight control of air traffic; R F Hansford, Decca Radar Limited.

[9] Operational Problem Areas in the Application of Data Processing to air traffic control; F McDermott, Federal Aviation Agency.

[10] Some developments in techniques related to data handling; L Airey, NGTE, Min of Supply, UK.

[11] A high speed data handling system for the English Electric GW Division Intermittent Wind Tunnel; E Patterson and D Readshaw.

CONTRIBUTIONS

The editor invites authoritative and thoughtful contributions on all aspects of automatic data processing. Factual accounts of first-hand experience in planning, installing and operating computer systems are particularly invited; but theories and prognostications based on practical experience in commerce, industry and government are also welcome.

Articles, preferably between 2,000 and 3,000 words in length, are most acceptable when typed with double spaced lines on plain quarto paper. They should be addressed to:

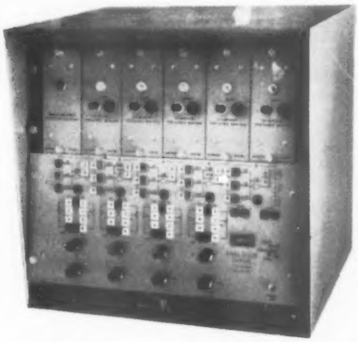
The Editor
AUTOMATIC DATA PROCESSING
Mercury House, 109-119 Waterloo Road
London, SE1

Accessories

Analogue Machine for Training

BILLED as an analogue training device, the recently announced TY 963 Solartron Analogue Tutor is a simplified analogue computer intended for educational purposes.

Capable of representing any form of linear second-order differential equation using the built-in computing components, and of demonstrating, for example, the effects of velocity and acceleration limits using external diodes as additional computing impedances, within limits imposed by the total complement of five amplifiers, a wide range of physical systems may be represented.



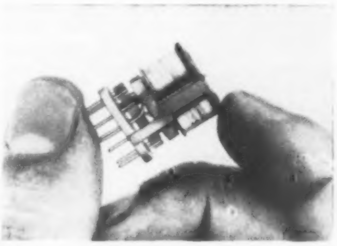
Can be linked to other computers

Interchangeable component assemblies permit the Analogue Tutor to be incorporated into more complex analogue computer installations if required.

The Solartron Electronic Group Ltd,
45 Thames Street,
Kingston,
Surrey.

Micro-miniature Relays

AT present being sold under licence from the Danish firm, Telefon Fabrik Automatic, are micro-miniature relays—type RZO. These are hermetically sealed relays, tiny yet rugged enough to withstand extremes of temperature, shocks and severe vibration without affecting their reliability. Fast



Withstands temperature extremes

operation, high contact rating, long life and low power consumption are among some of the features that make them suitable for use in, among other equipment, computer systems.

Counting Instruments Ltd,
5 Elstree Way,
Boreham Wood,
Hertfordshire.

Trace Reading Equipment

DEVELOPED by Southern Instruments Ltd is electronic equipment—identified as TRE 12—designed for the analysis of physical parameters recorded in *analogue* form as oscillograph traces.

An electric motor provides fast chart drive, either forward or in reverse. Control is by push-buttons which actuate magnetic clutches; manual fire control of the chart position is provided.

Linear and non-linear calibration can both be handled by this equipment and a single cursor is used for all readings. The record for conversion may contain up to 12 independent channels. In a single scan of the chart all channels may be converted and presented in digital form; each in actual units of the original parameter.

Output from the equipment may be used to operate an electric typewriter, a tape perforator or a

Several possible output forms

card punch, either singly or simultaneously. Additionally, a visual display is included in the cabinet containing the electronic units.

Loading the record is simple and may be carried out from the operating position.

Calibration curves of any type are easily generated and a separate curve is used for each channel, giving complete flexibility. These curves are produced on graph paper fitted to a drum, and both curve and record are traversed by a single short cursor.

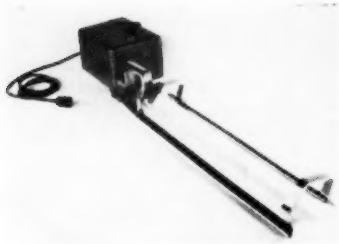
Readout may be controlled by push-button or a foot switch. The stepping on to the next channel is automatic and the operative channel is shown on a digital display above the trace window.

Southern Instruments Ltd,
Frimley Road,
Camberley,
Surrey.

Cuts out Carbons

AN inexpensive attachment for IBM accounting machines (407, 420 and 421) has been developed by James Wilkes Ltd. This—a 'ribbon feed' attachment—utilises a standard IBM ribbon and spool. The fabric ribbon is fed at controllable speeds and tensions across the full width of the platen at the print line, and is turned by a control bar at the end of the tabulator carriage to return along the same line.

In this way, passing twice between the webs of continuous forms, the attachment allows per-



Minimum set up time

fect duplication of up to five parts, without the use of costly carbons.

The standard IBM fabric ribbon will produce thousands of legible impressions and its life is lengthened by the attachment's variable ribbon speed control.

The attachment has two further advantages: very little stationery set up time is involved, and machine stoppages to remove carbons are eliminated.

James Wilkes Ltd.
Bilston,
Staffordshire.

For Digital Print-out

A DIGITAL data recorder comprising a precision 50-channel commutator, an analogue-to-digital converter of high accuracy, and a digital print-out unit, and coded LP981 has been developed by Solartron, who list a number of possible applications for the device: monitoring of plant and processes; transducer calibration, instrumentation of IC, jet and rocket engine test cells; also of wind tunnels and hydrodynamic test tanks. In addition, it may be used for the automatic check-out of missiles and the other complex devices; continuous logging of temperatures, pressures, etc, in nuclear power plant; environmental and astrobiological research.

Commutation of inputs is by a relay bank with associated transistorised logic circuits mounted on removable printed circuit boards. This use of relays, with gold-plated contacts, avoids most of the difficulties encountered in rotary commutation, also the arrangement lends itself to multiple mode control so that the following three operational conditions may be achieved:

1—Continuous automatic sampling at a rate of two inputs per second, or—

2—Single scan of the 50 inputs after receipt of an external command, or—

3—Manual selection of any one channel by push-button.

Analogue-to-digital conversion is effected in a Solartron digital voltmeter (Type LM 902) which provides decimal output information for operation of the printer.

The print-out provides, on 3-inch wide paper, a permanent record consisting of channel number (1 to 50), measured signal value (4-digit), and the polarity of input.

The recorder is priced at approximately £1,550.

The Solartron Electronic Group Ltd.
Thames Ditton,
Surrey.

Two new Add-listing Machines

INTRODUCED for the first time last month were two new Addo-X add-listing machines. A hand-operated Model 49 sells at £49 while the electrically-operated sister Model 49E is priced at £69. These low-priced machines have all the standard features—addition, subtraction, repeat, sub-total, total and printed results—and a capacity of up to £99,999 19s. 11d.

Bulmer's Business Machines Ltd.
Empire House,
St Martin's-le-Grand,
London, EC1.

Pocket Adding Machine

FOR executives who want to avoid scribbling additions on the backs of envelopes a pocket adding machine in a leather case, with a note-pad and pencil-stylus, known as the Addmaster-Baby, adds on one side, subtracts on the other, and is very simple to work.

THE NEW FORD BIAX ELEMENT

Aeronutronic, a division of the Ford Motor Company in the United States, recently announced a new computer element capable of multimegacycle performance in logical networks and memory stores.

The Biax element is a small rectangular bar of ferrite magnetic material measuring 50 x 50 x 85 mils. It represents, according to Aeronutronic, a 'significant advancement' in magnetic computer elements, making possible the achievement of reliable high - speed computing at reasonable cost.

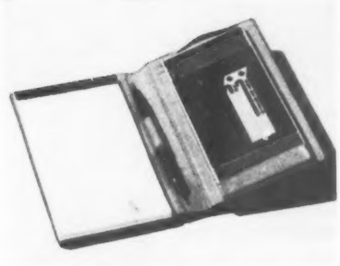
The basic concept in Biax is that of flux interference between orthogonal magnetic fields. This is accomplished by means of two 20-mil orthogonal holes through the element. The flux interference takes place in the magnetic material between the holes. Because of the orthogonality, no normal magnetic coupling occurs between conductors associated with the two holes in the materials.

By controlling the spacing between the holes, the flux interference techniques can be made destructive or non-destructive. Memory applications employ the non-destructive element and logical circuitry employs the destructive element.

In the memory element, one of the orthogonal holes acts as the storage axis while the other hole acts as the non-destructive interrogate axis. The logical element employs the same orthogonal hole technique, but with the difference that the holes are placed extremely close together.

The Biax element makes possible a very rapid random access memory unit. Elements have been interrogated more than 100,000 million times at a ten-megacycle rate, with no loss of output signal, indicating a true non-destructive read-out and low heating. The element has been tested in operation at extremely high temperatures.

It is claimed that in production, Biax equipment will be very cheap, extremely compact and capable of operating with smaller power currents than are now used in computing equipment.



For totting up expenses?

There are six columns on the face of the Addmaster, three for pounds, two for shillings and one for pence, giving it a total capacity of £999 19s. 11d. The model costs 37s. 6d.
K Bisset & Co,
145 Trafalgar Square,
London, WC2.

Swiss Add-listing Machines for Britain

THE Muldivo Calculating Machine have been appointed sole agents for Ultra add-listing machines which are manufactured by the Swiss company, Oerlikon Machine Tool Co. Two models are currently being offered in Britain, the Ultra H 8-8 and the Ultra E 7 S.
Muldivo Calculating Machine Co Ltd.
Dorset House,
Salisbury Square,
Fleet Street,
London, EC4.

Binding Kit

A SELF-BIND standard kit which costs £27 6s contains all that is necessary for binding together sets of documents. Bound together the contents of a lever arch file, it is claimed, will be contained within less than two-thirds of the space taken up by a transfer storage file.

Invoices, orders, correspondence, vouchers, travellers' reports, delivery returns and similar records, can all be bound daily, weekly or monthly, according to volume, using this kit.
Westwood Paper Ltd.
185 Goswell Road,
London, EC1.

Like most do-it-yourself kits this binding set is complete with all the materials required. Above right: how it is used.

INDEX TO ADVERTISERS

AUTOMATIC DATA PROCESSING

INDEX TO VOLUME I

The issue numbers are shown in bold type, thus: **6:** and the page references are shown in light type, thus: 24.

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IBM United Kingdom Limited, 101, Wigmore Street, London, W.1.

Quoting reference: 60/10.

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To create the design of new computers and to develop fault detection and location techniques.

Positions are available at salaries from £750 to £1,350 per annum.

Candidates who feel that they have the right qualifications and enthusiasm for the above vacancies should apply giving full details to Staff Manger, General Electric Co. Ltd., Copsewood, Coventry.

ICT

EXPERIENCED COMPUTER PROGRAMMERS

I.C.T., the largest British manufacturer of data-processing equipment, is now engaging considerable numbers of experienced computer programmers to form a new team in the rapidly expanding computer organisation. Included in this requirement are a number of senior appointments.

Applicants—men and women—should be aged between about 25 and 35. They must have had at least one year's practical experience of programming digital computers on commercial or scientific procedures. Special consideration will be given to applicants who have had several years' programming experience.

Successful candidates will work mainly in the Greater London area.

Write, giving brief details of education and experience, to The Manager, Personnel and Training Division (P.1), 149 Park Lane, London, W.1.

INTERNATIONAL COMPUTERS AND TABULATORS LIMITED

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Substantial and progressive salaries will be offered to applicants of proved ability and experience.

Applications will be treated in confidence and interviews arranged in London if necessary.

Write to: **Mr. S. G. Deane, Personnel Manager, Standard Telephones and Cables Ltd., Corporation Road, Newport, Mon.**

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Executive Director required to manage intricate, fast moving "figure factory" at Berkhamsted producing TAMRATINGS reports for the television industry. This unit, which employs over 200 men and women, is one of the largest statistical production organisations in Britain.

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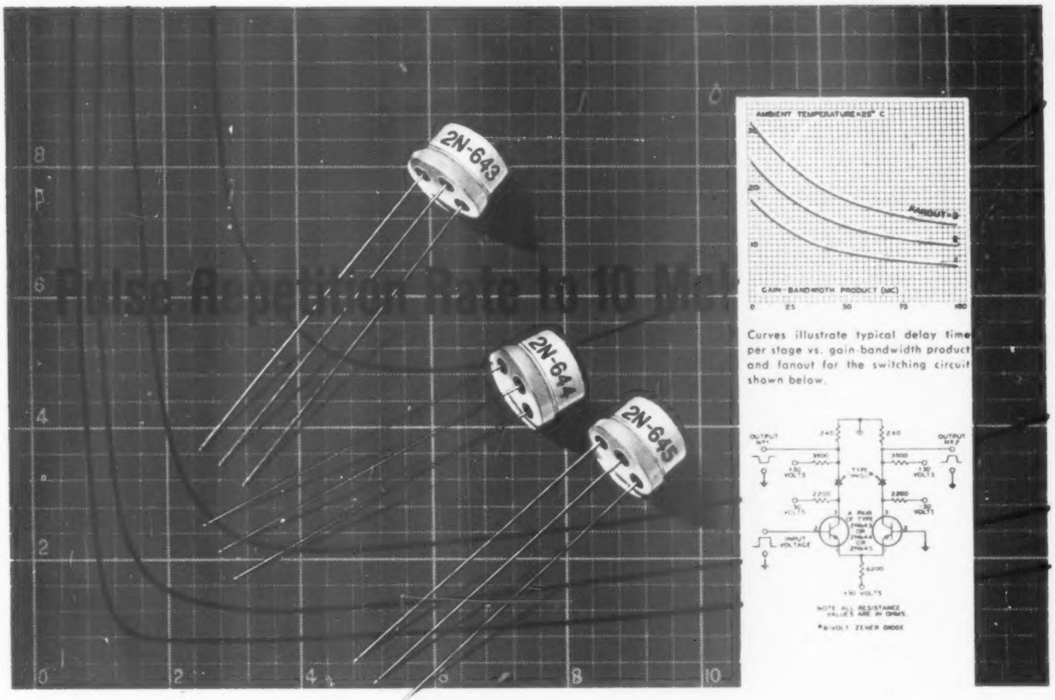
His starting salary will be in the range of £2,000-£2,500.

Write to: Vice-Admiral Sir Guy Sayer,
Television Audience Measurement Limited,
Chantrey House, Eccleston Street,
London, S.W.1.



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TYPE	2N643	2N644	2N645
Minimum gain-bandwidth product* Mc	20	40	60
Minimum collector** breakdown volts	30	30	30
Minimum DC current transfer ratio*	20	20	20
Maximum collector capacitance μμf	5	5	5

*Collector Volts = -7, collector ma = -5
**Collector Current = 100 μa

RCA

For technical data write to:

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(An Associate Company of Radio Corporation of America)

Lincoln Way, Sunbury on Thames, Middlesex. Tel: Sunbury on Thames 3101.

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